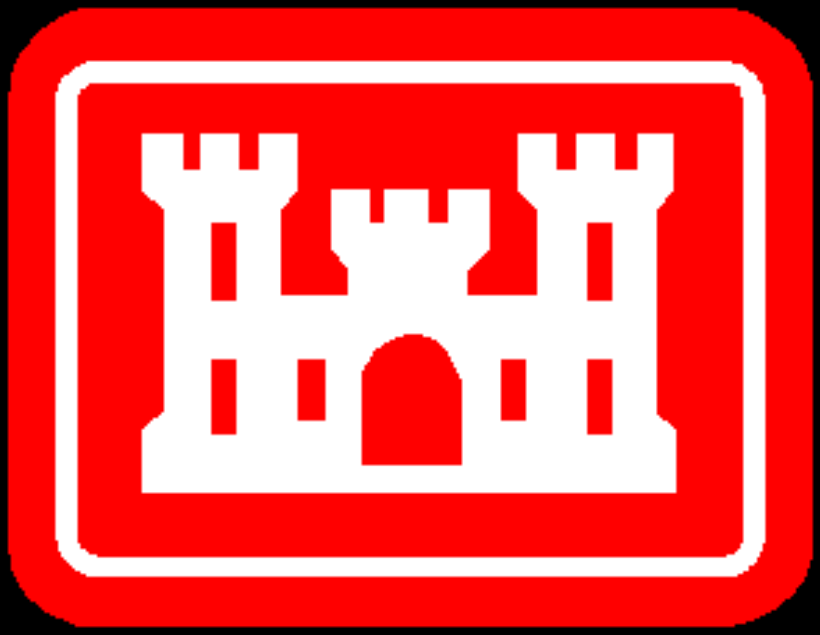

US Army Corps
of Engineers®

US ARMY CORPS OF ENGINEERS
ENGINEER RESEARCH AND DEVELOPMENT CENTER (ERDC)
TOPOGRAPHIC ENGINEERING CENTER (TEC)
ALEXANDRIA, VIRGINIA

GIS-Based Historical Aerial Photo Analysis for Environmental Remediation

BY

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PHYSICAL SCIENTIST

703-428-8351

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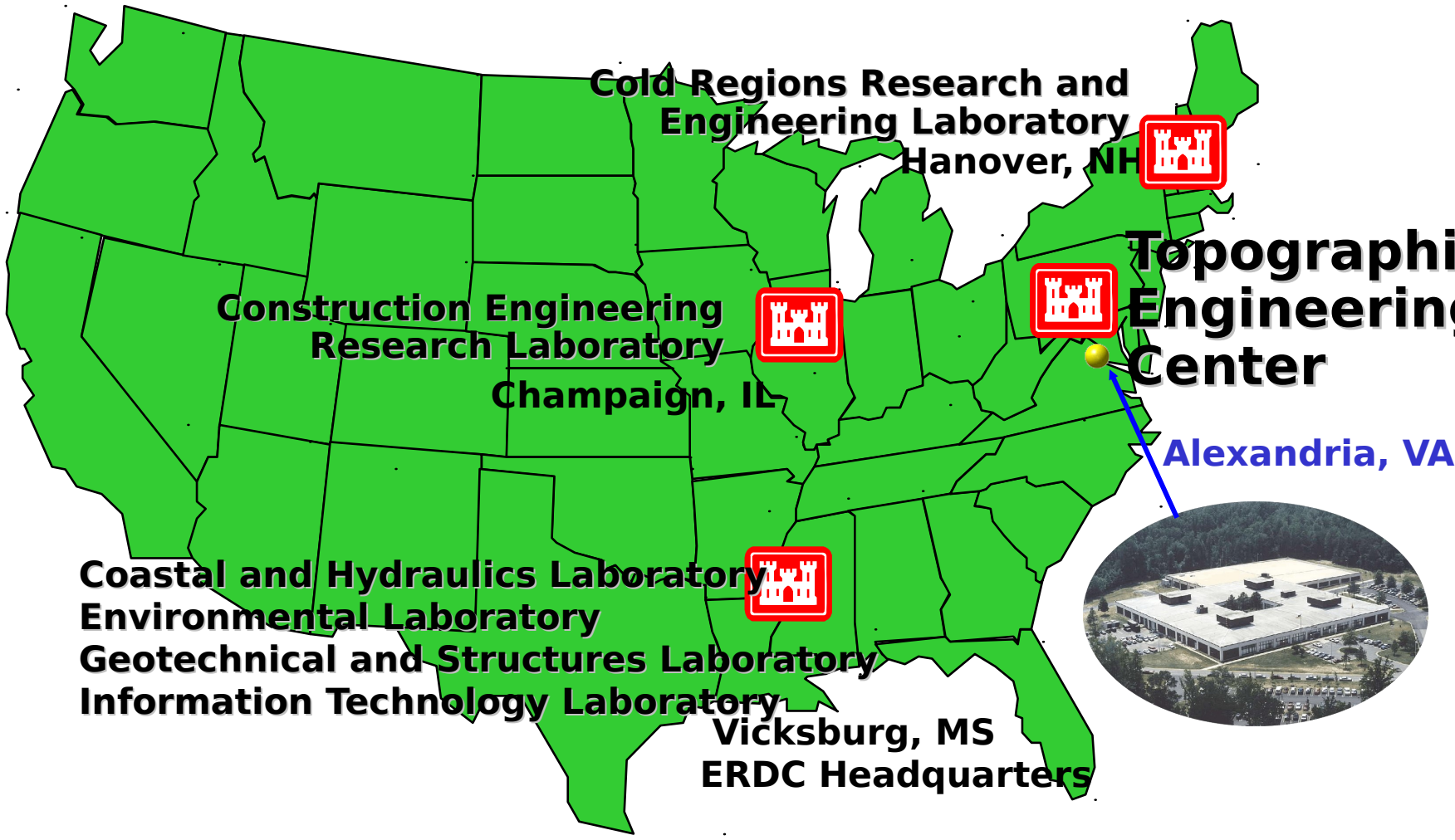
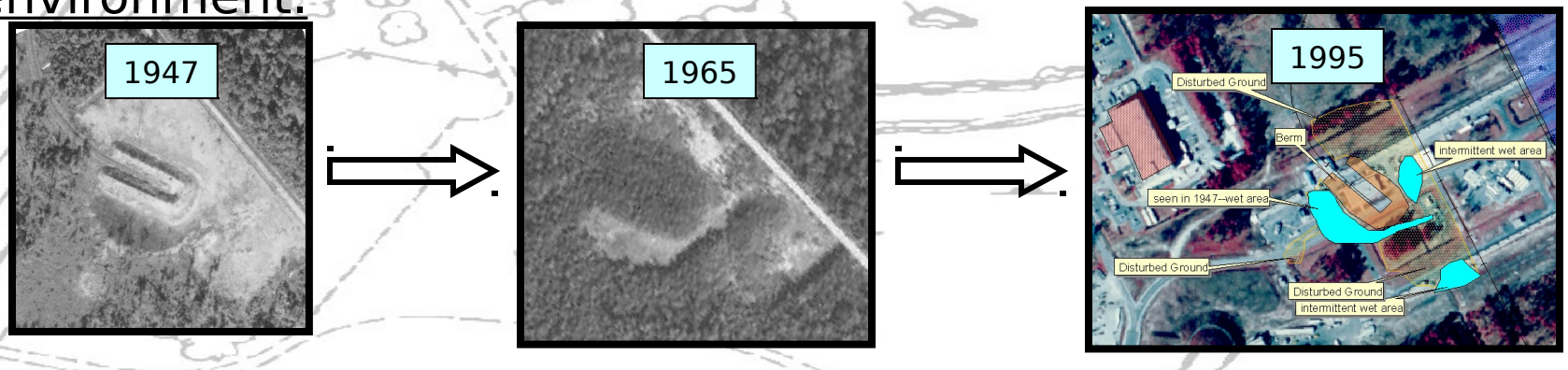
Where is TEC located?



Engineer Research and Development Center (E

- The U.S. Army Engineer Research and Development Center (ERDC), Topographic Engineering Center (TEC), Hydrologic and Environmental Analysis Branch conducts GIS-based Historical Aerial Photographic Analyses of current, closing, and former U.S. Military installations.
- These analyses help locate potential contamination sites. These sites may contain hazards such as chemical warfare materials (CWM), unexploded ordnance (UXO), radioactive waste or landfills.
- TEC also conducts GIS-based Historical Photogeologic Analyses in areas where groundwater contamination is a concern. Surface features that can influence the migration of contaminants (rock fractures, sinkholes, drainage features, and wetlands) are mapped as baseline information for site characterization and/or for geophysical studies.
- We also analyze aerial photography to provide information for sites with other environmental concerns. These include riparian analysis, historical wetland evaluation, shoreline changes, and watershed/land use mapping.

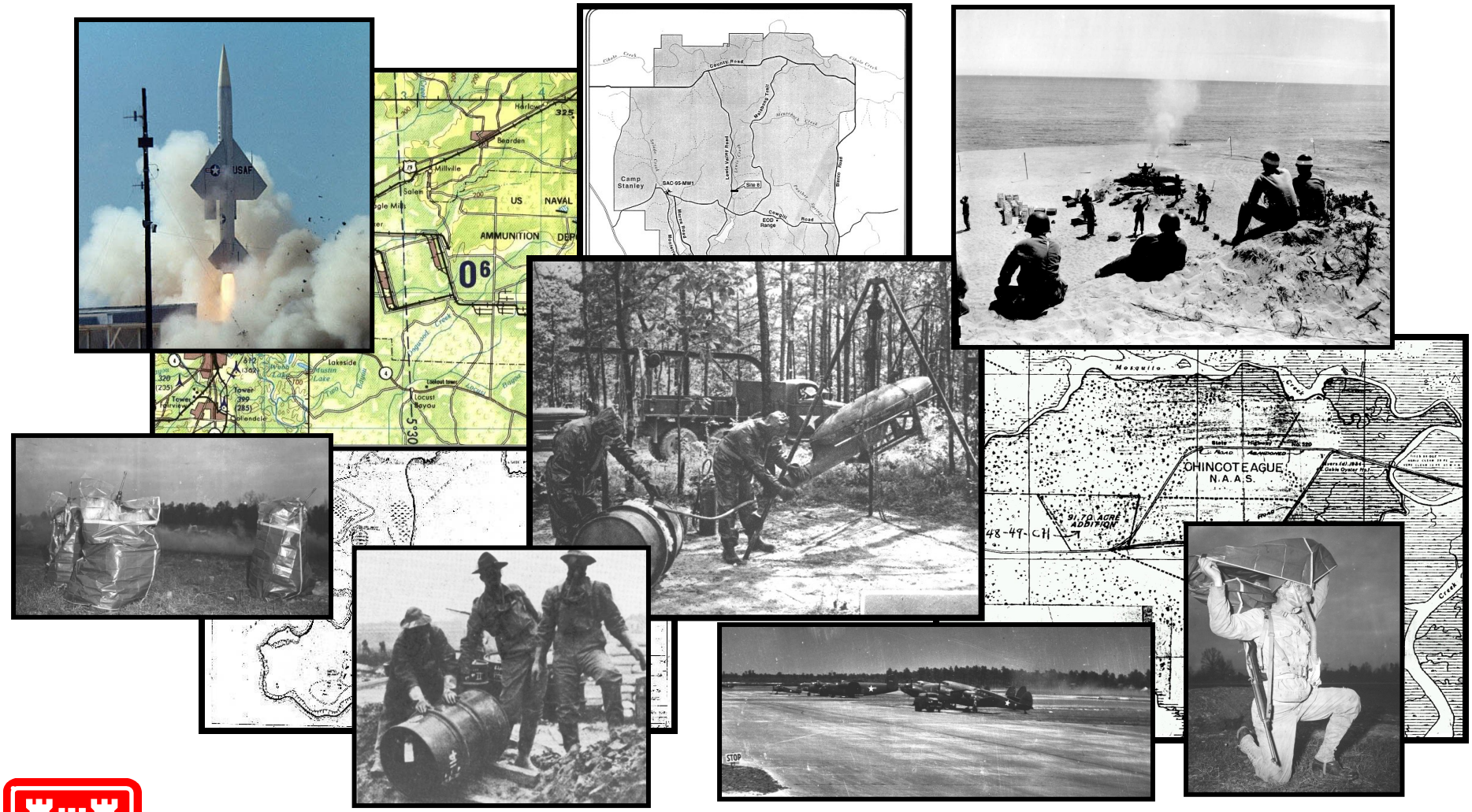
- The use of Geographic Information Systems or GIS is a primary component of the work and allows customers to view multi-layer “time-sequenced” data in a digital environment.



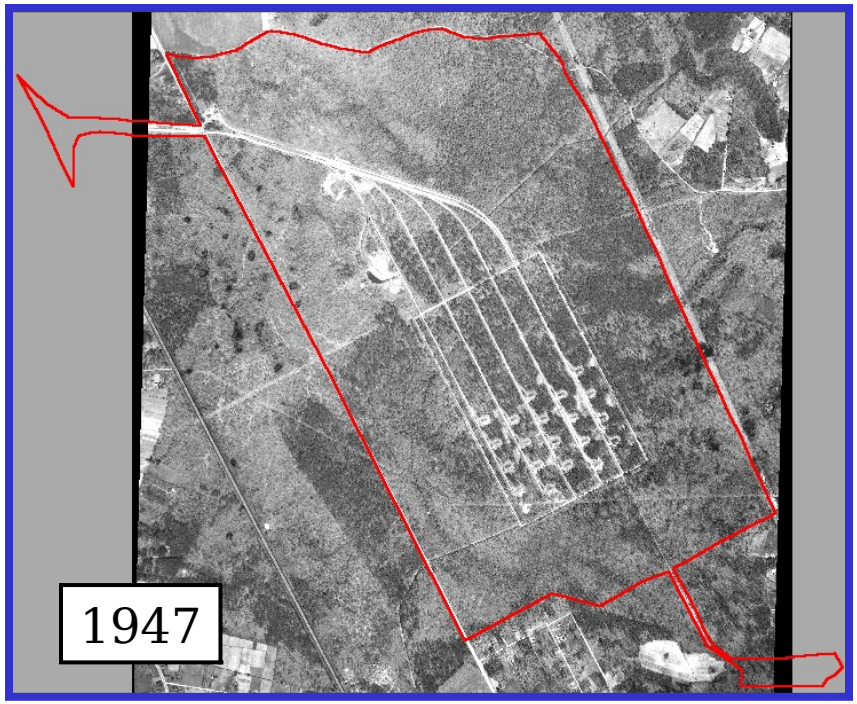
- We have an interdisciplinary team of geologists, geographers, foresters, biologists, physical scientists, photogrammetrists, cartographers and archival researchers.

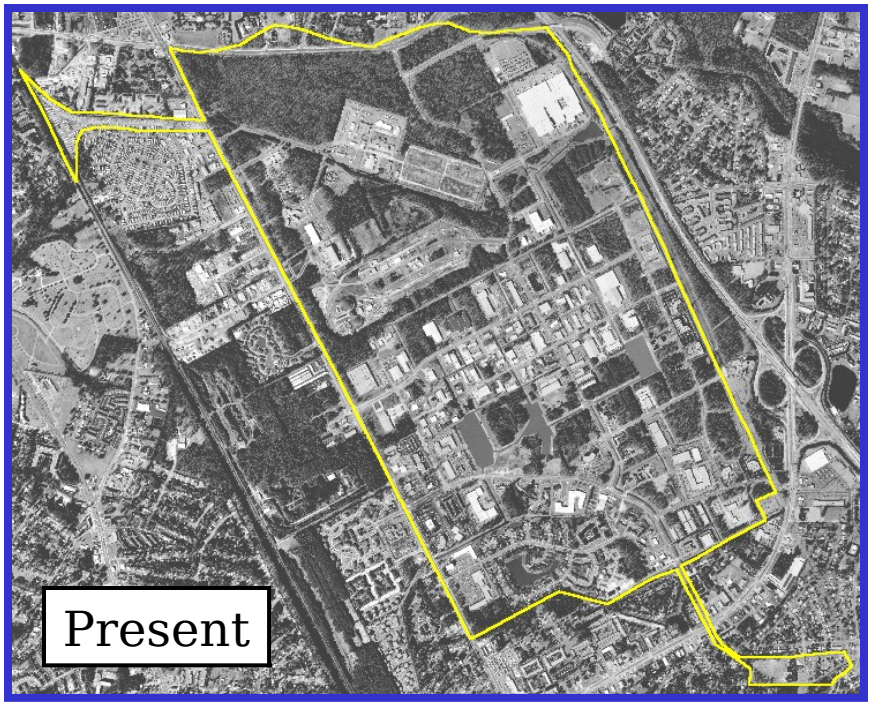
- The identification and remediation of hazardous sites is a problem faced by many active, closing, and former U.S. military installations.

- The problem is complicated by the fact that many of these sites were created by practices and activities undertaken years or decades ago.



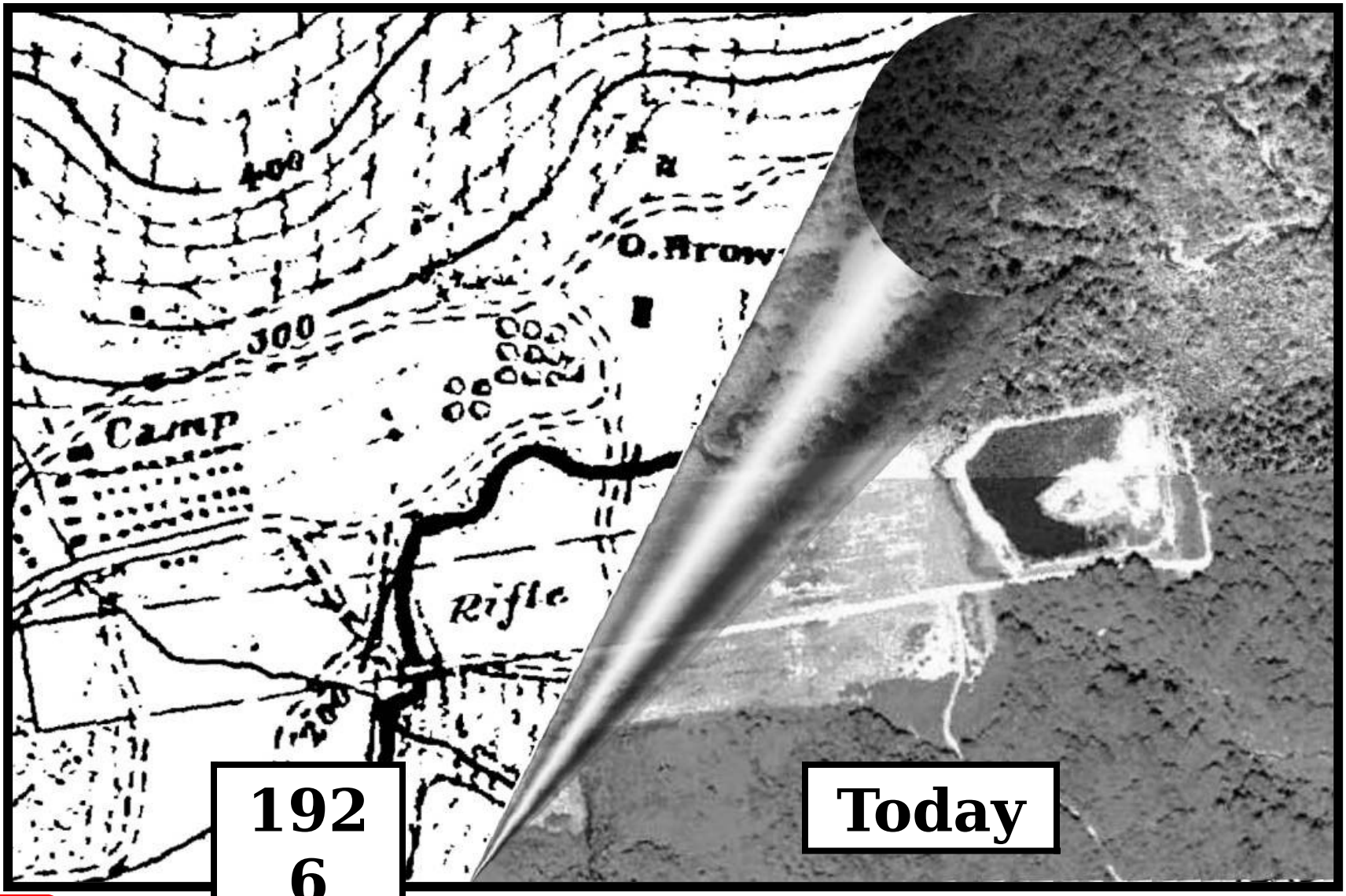
- Hazardous sites are often completely obscured today due to the burial of materials, rapid revegetation, or dramatic changes in land use.



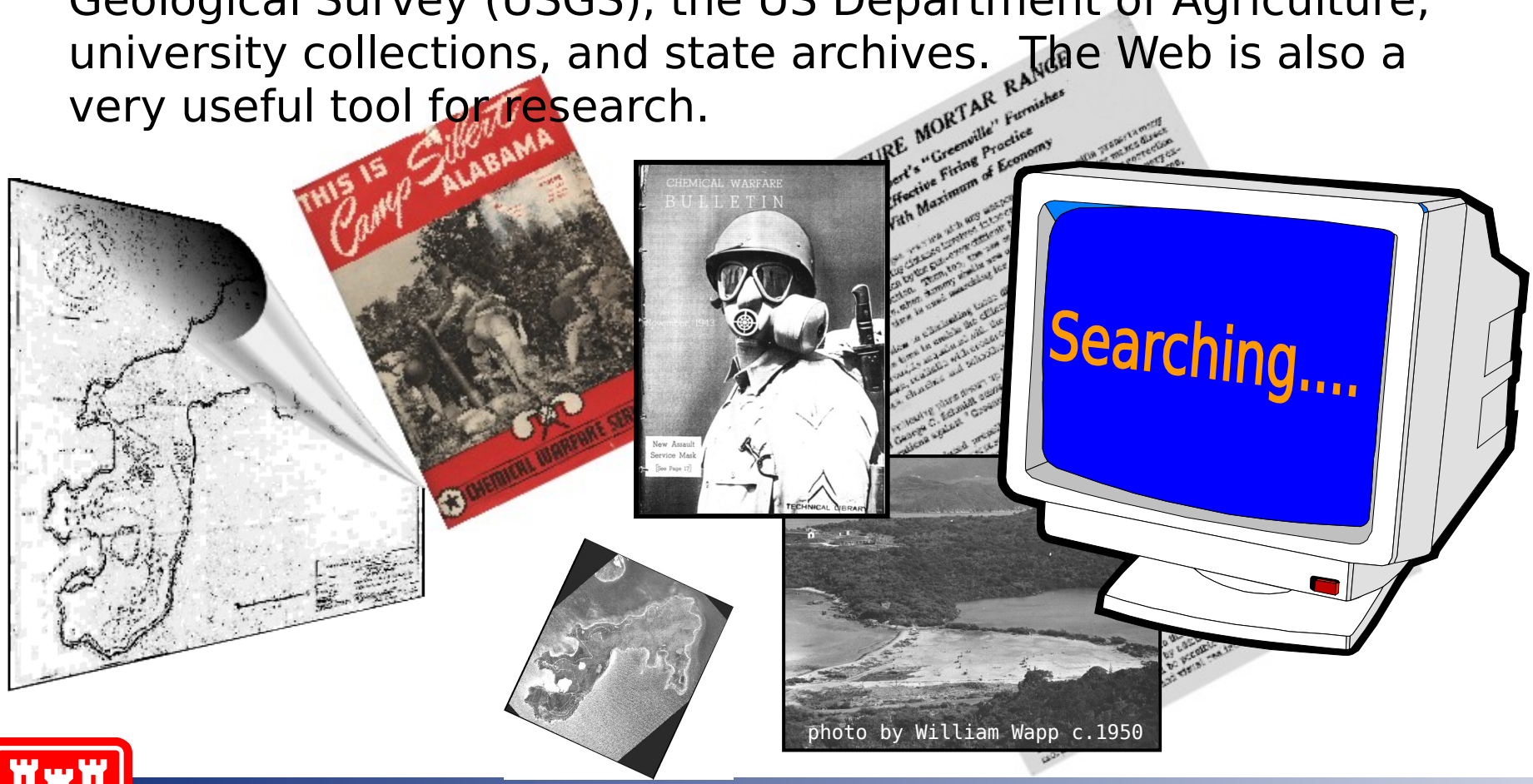


Present = late 1990's aerial photo

“Discover the Past”

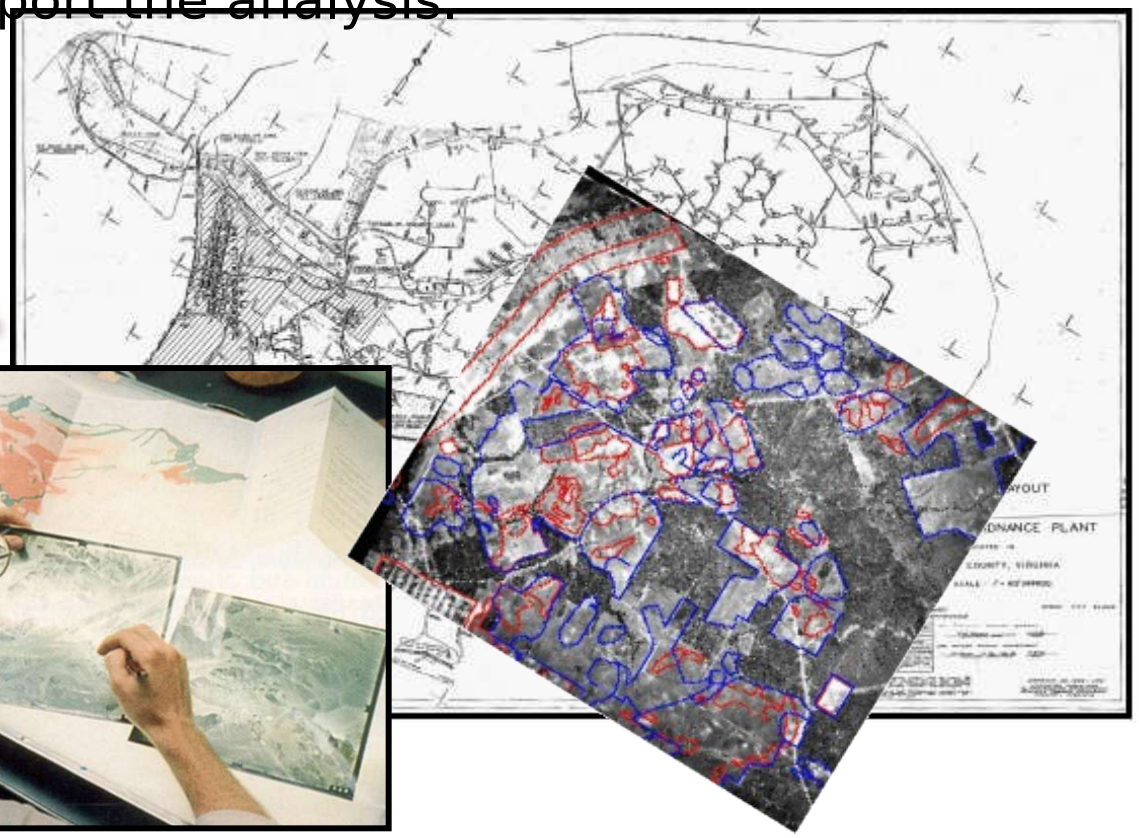


- To locate aerial photographs as well as maps, ground photos and documents, we visit and query government, academic, public and private holdings. These sources include the National Archives and Records Administration, private aerial photography companies, military history offices, the US Geological Survey (USGS), the US Department of Agriculture, university collections, and state archives. The Web is also a very useful tool for research.

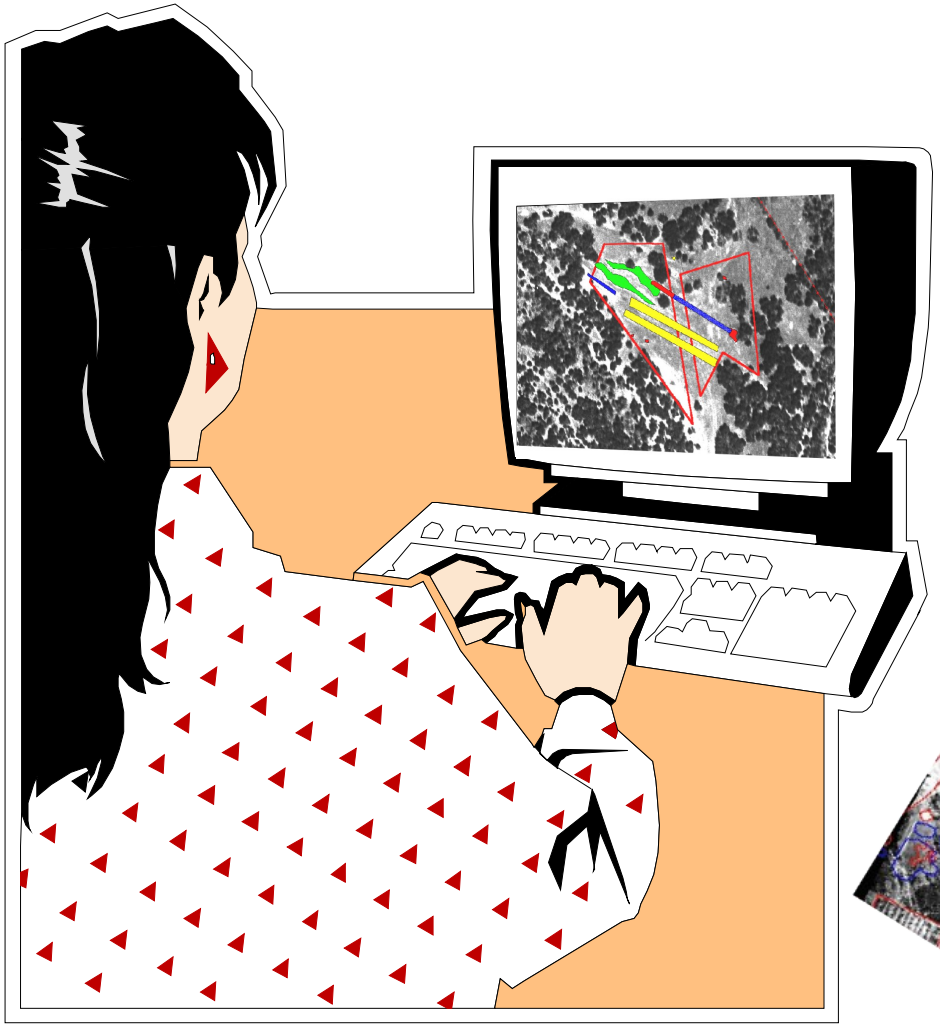


- A primary tool used in analysis are historical aerial photographs. These are viewed in stereo or "3-D" in order to see trenches, pits, impact craters, structures, sinkholes, etc. We often look at hundreds to thousands of photos for a site (depending on site size and years of coverage). Maps and documents (such as the Corps' Archives Search Report or ASR) are also reviewed to support the analysis.

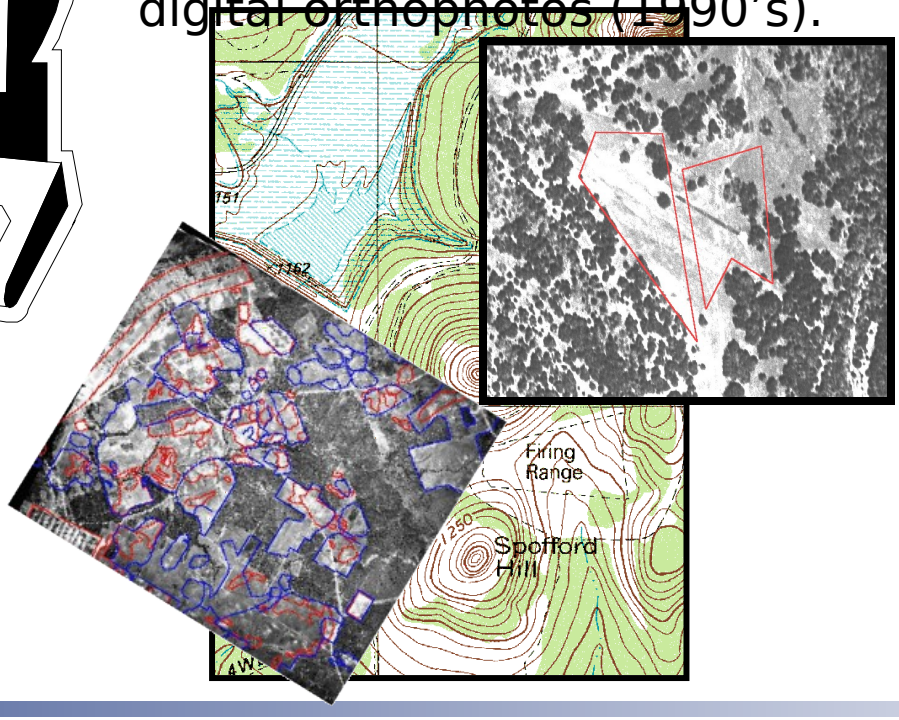
stereoscope



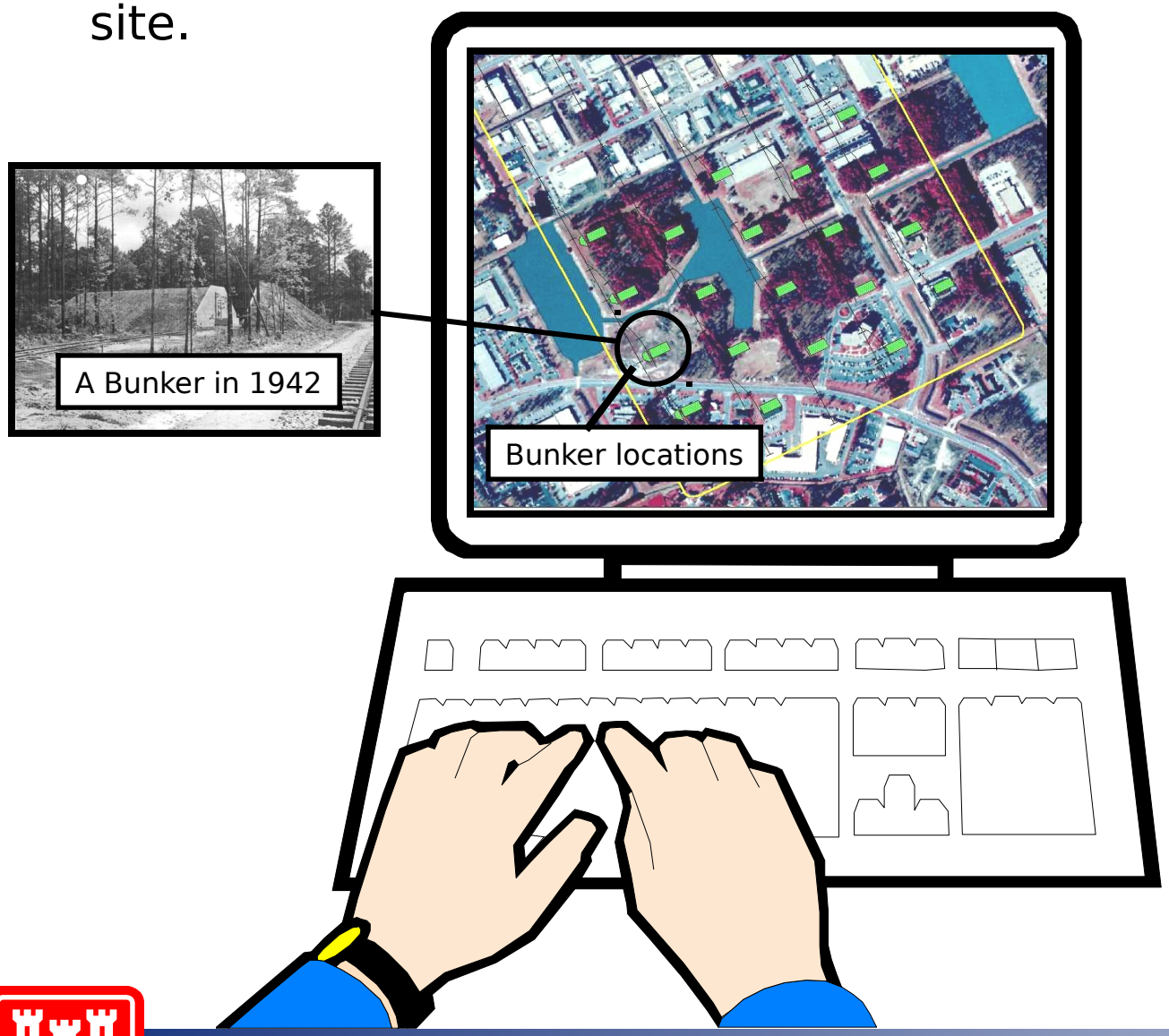
- Features or possible areas of concern (AOC), are mapped on the historical aerial photos and then transferred to a digital, historical aerial photo map.



- Existing current, digital aerial photo maps (orthophotos) are used to register all of the data. New aerials can be acquired but this does increase cost. However much of the United States is covered by recent, digital orthophotos (1990's).

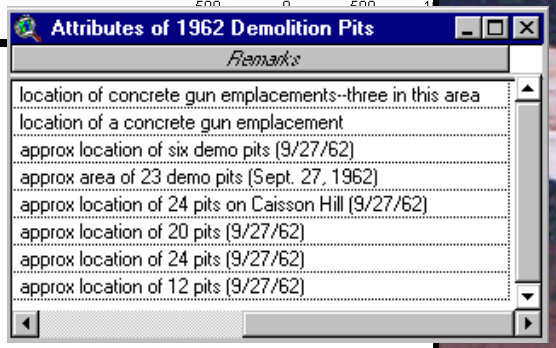


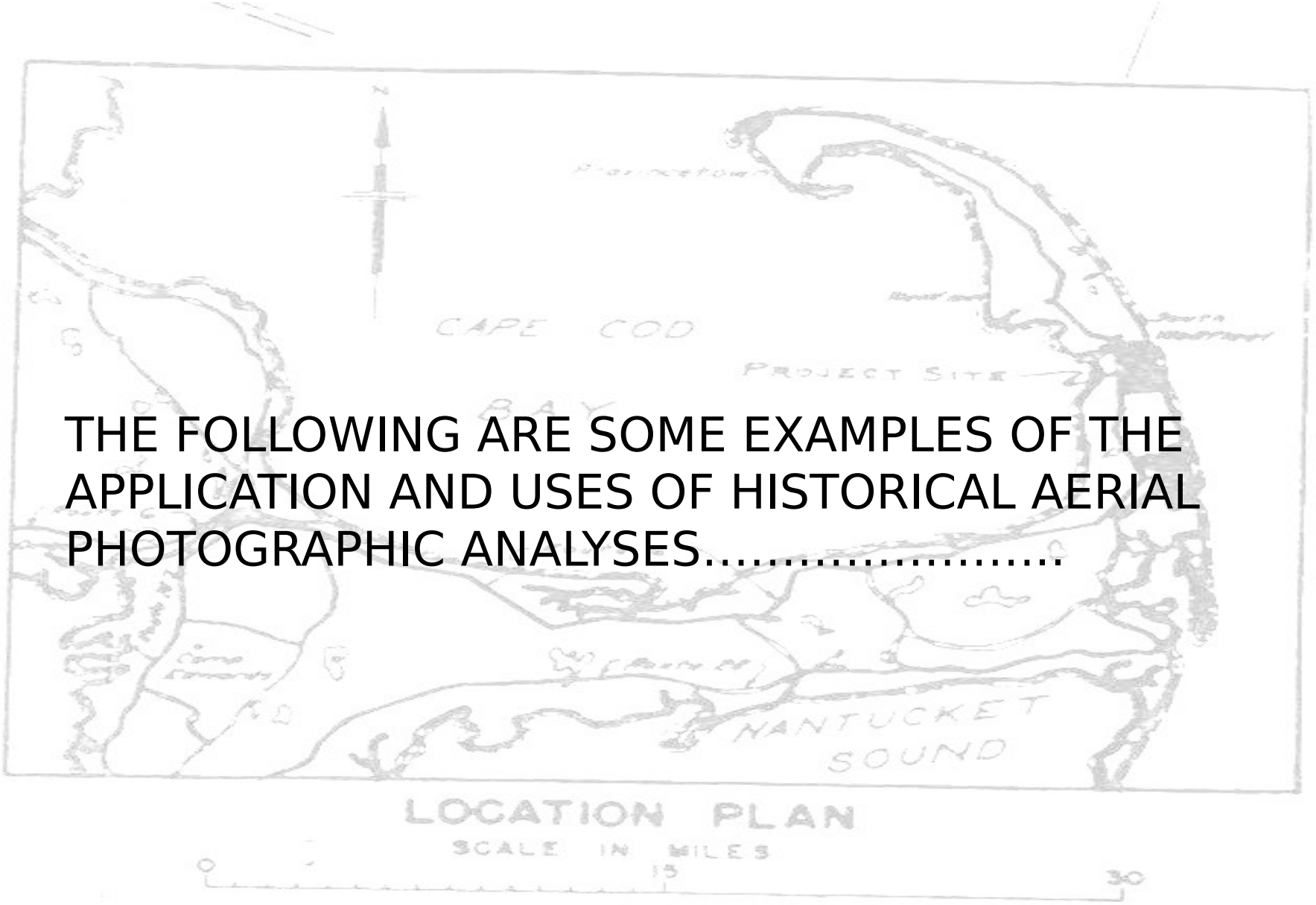
- Using the tools of a GIS, the historical features can now easily be superimposed onto a current orthophoto of the site.



- Mapped features will have a high degree of relative accuracy (i.e. an object is within a few feet relative to an adjacent object). Geographic positional accuracy will vary according to the orthophoto source.

- Information provided by project managers (customers) and data from field or site visits are often incorporated into the final product in the form of graphics, text and/or tables.

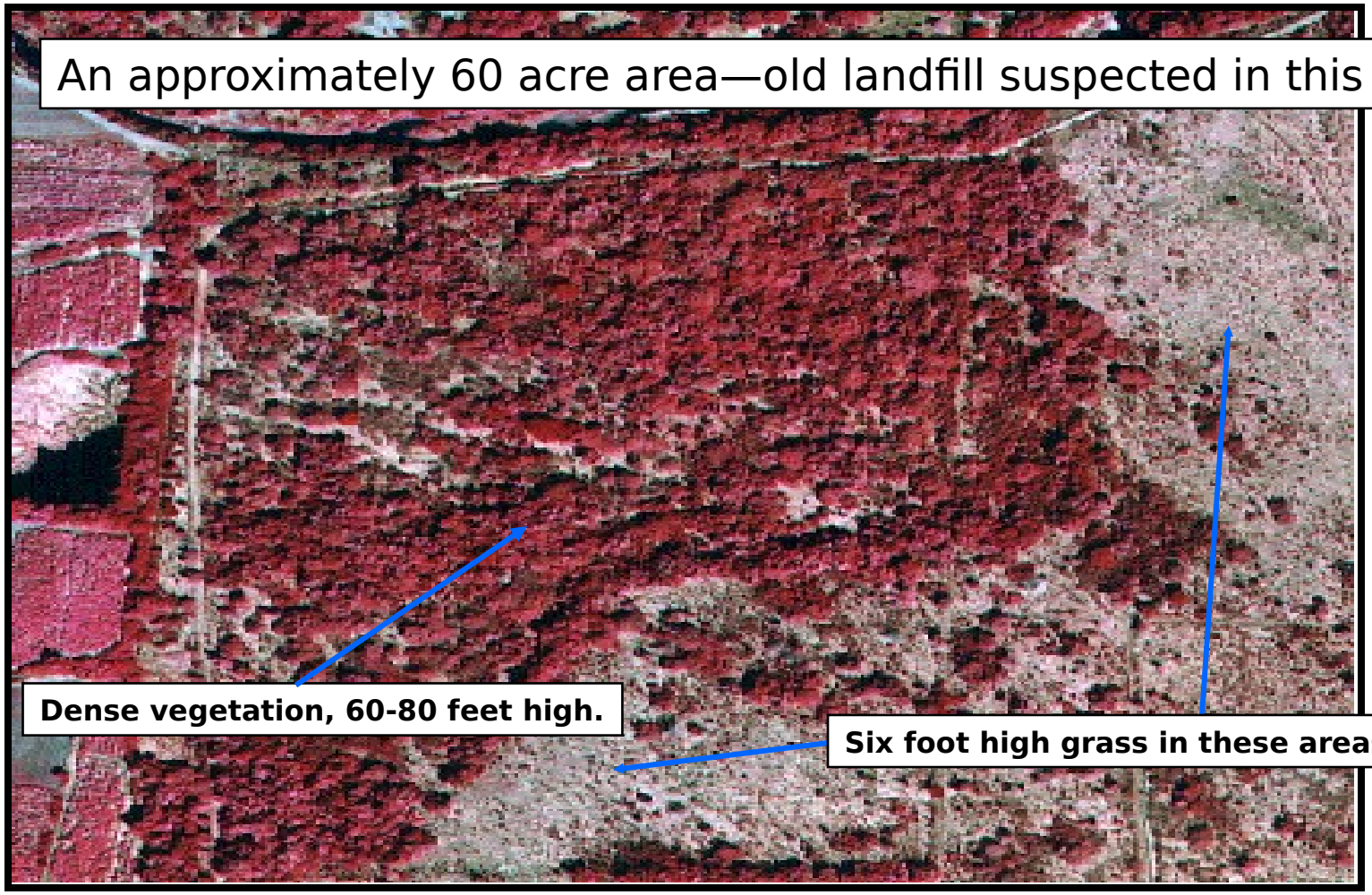

Attributes of 1962 Demolition Pits
Remarks
location of concrete gun emplacements--three in this area
location of a concrete gun emplacement
approx location of six demo pits (9/27/62)
approx area of 23 demo pits (Sept. 27, 1962)
approx location of 24 pits on Caisson Hill (9/27/62)
approx location of 20 pits (9/27/62)
approx location of 24 pits (9/27/62)
approx location of 12 pits (9/27/62)



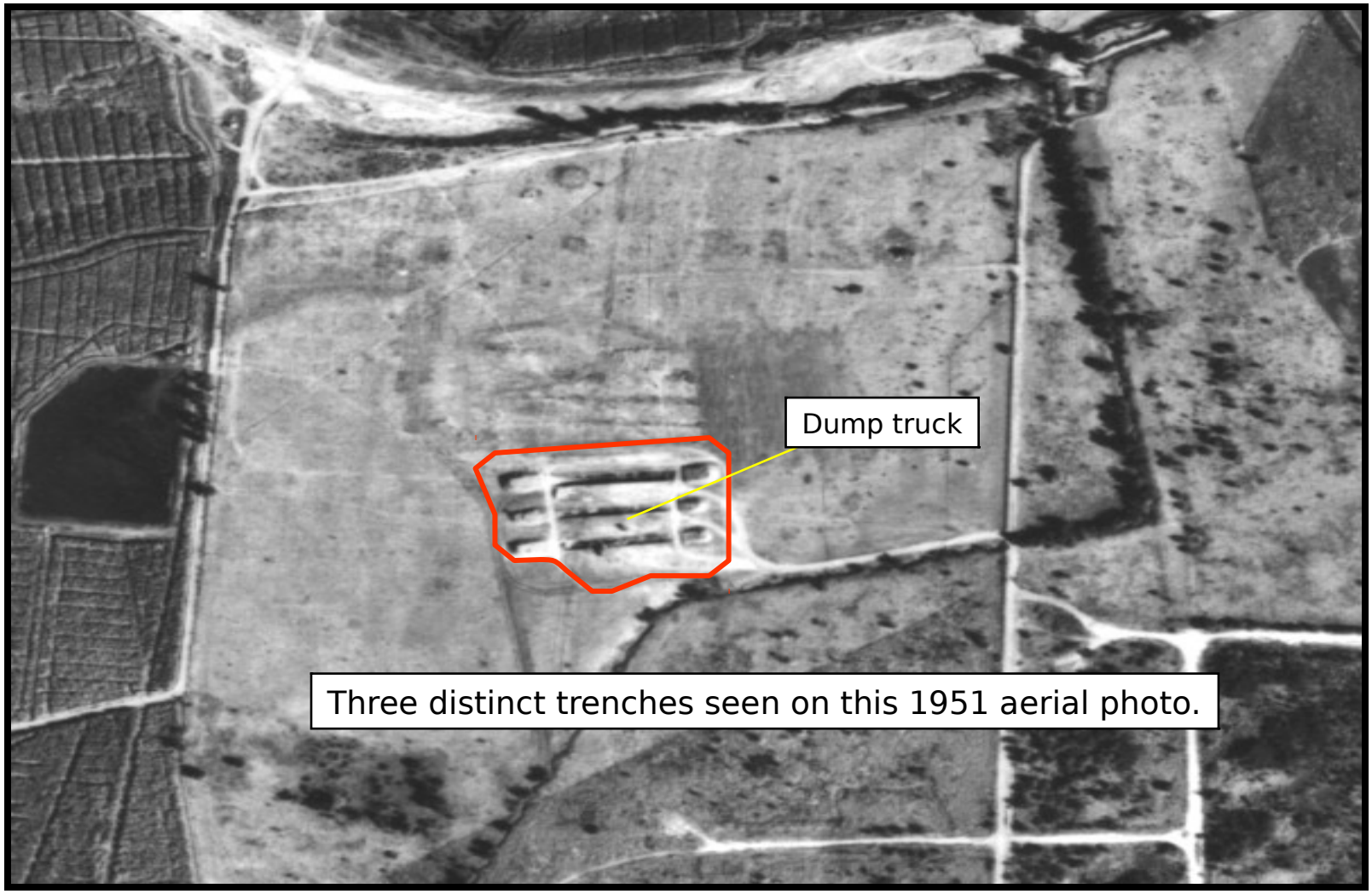
THE FOLLOWING ARE SOME EXAMPLES OF THE APPLICATION AND USES OF HISTORICAL AERIAL PHOTOGRAPHIC ANALYSES.....

1993 View in a Residential Community

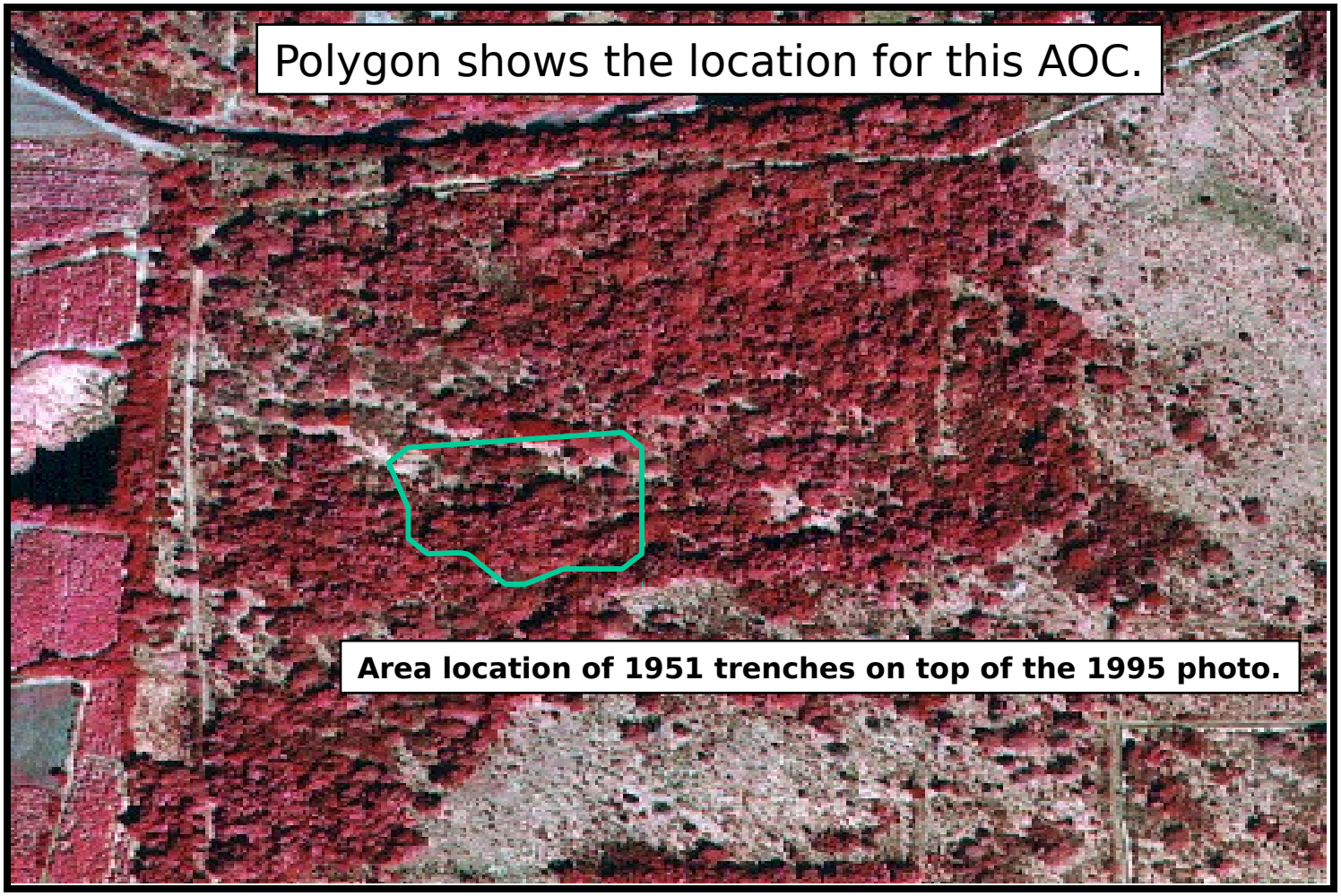
75 years earlier the area contained a Chemical Munitions Test Site


An approximately 60 acre area—old landfill suspected in this area.
Dense vegetation, 60-80 feet high.
Six foot high grass in these areas.

Puerto Rico site in 1995 - Current Landscape (color infra-red aerial photo)



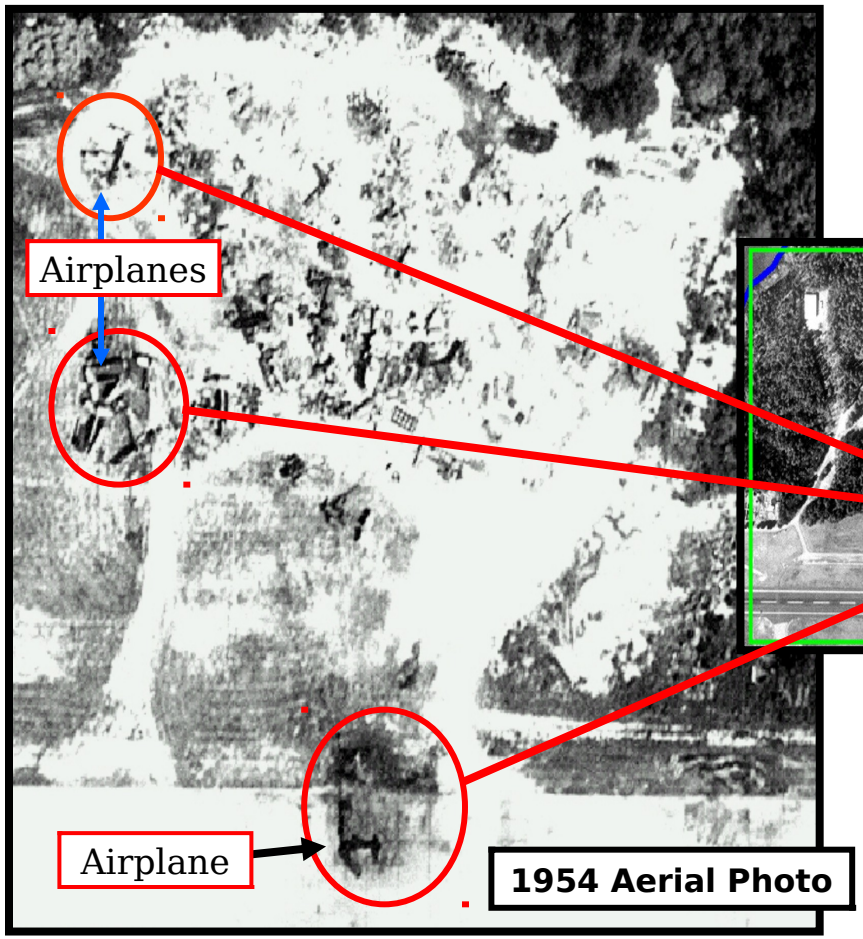
Puerto Rico site in 1951 - Historical Aerial Photograph



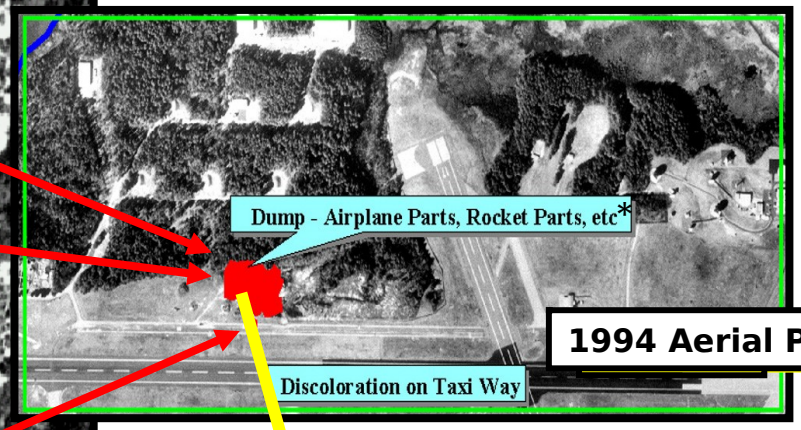
Puerto Rico site-1951 trench area shown on the 1995 aerial photo.

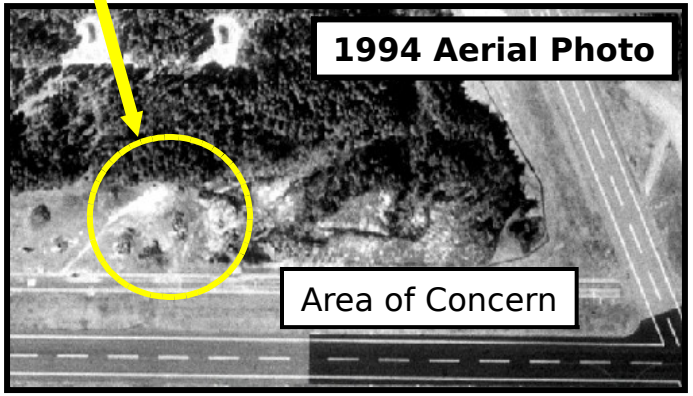
Dump area at an Airfield in Virginia

1954 Dump - Airplane Parts, Rocket Parts, etc.



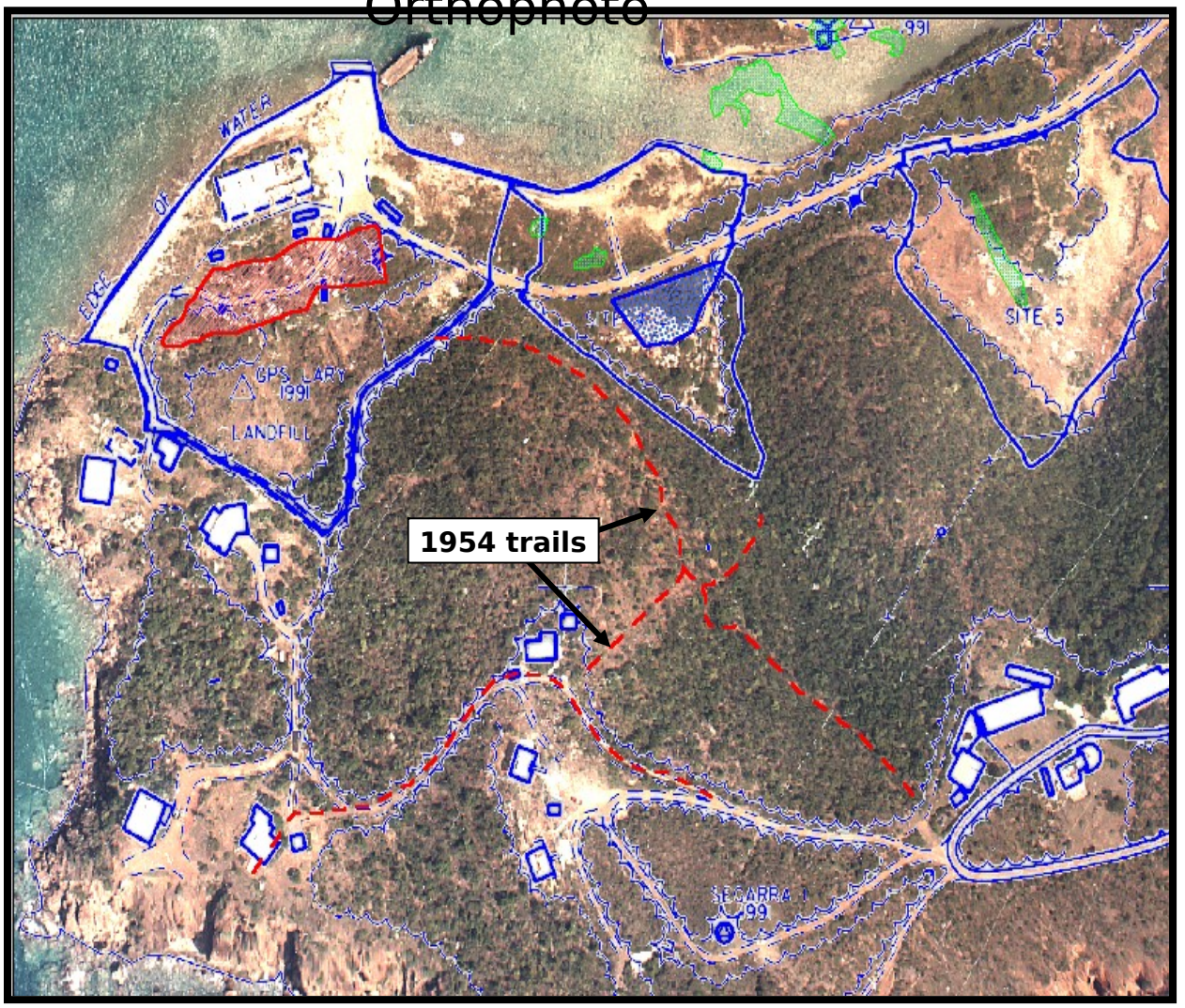
1994 Digital Orthophoto Base Close-Up





1954 Historical Features Superimposed onto a 1991 Orthophoto

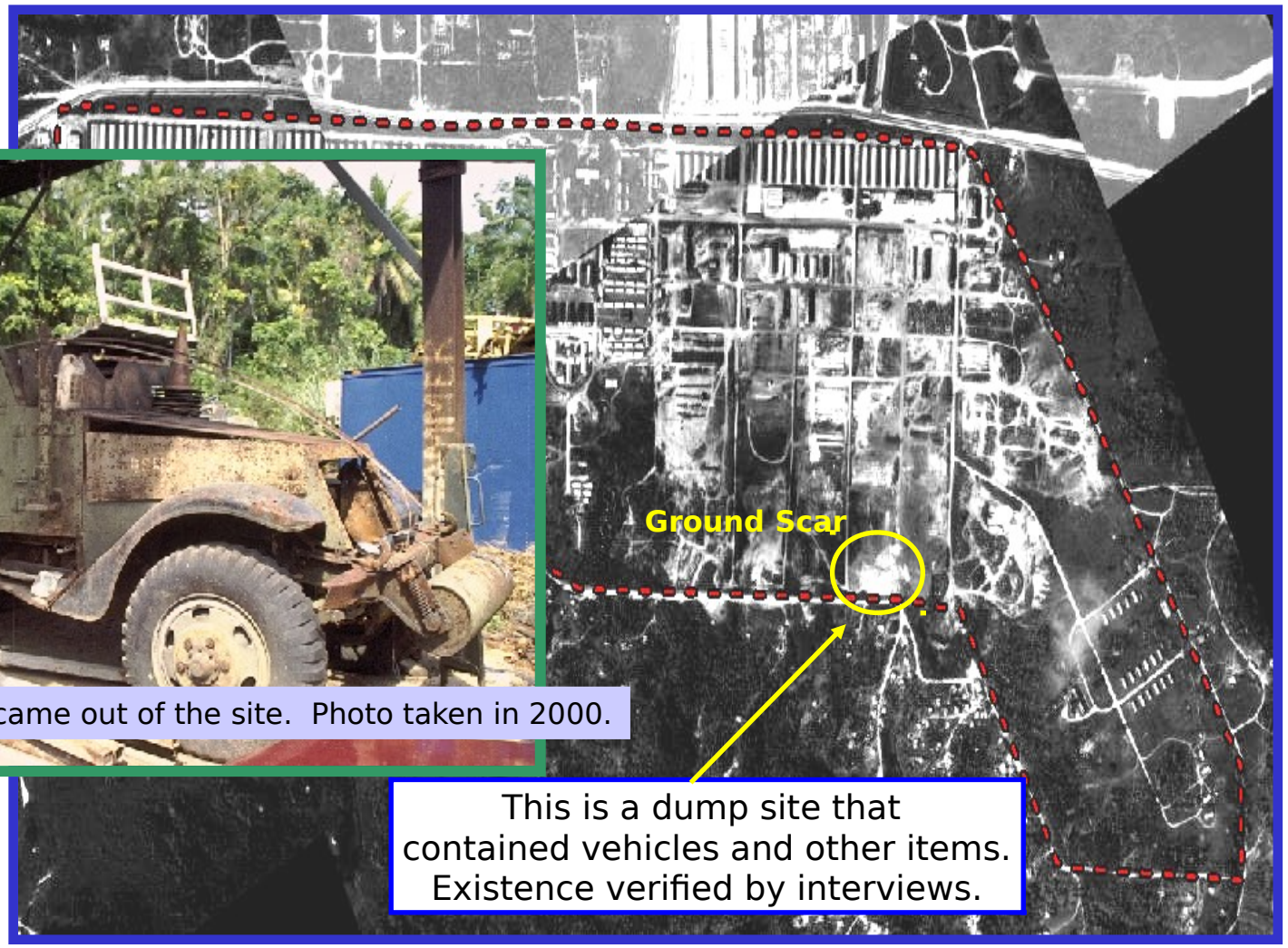
Legend



A 1991 “blue line” engineering drawing superimposed.

1949 Aerial Photo—former military base in Guam.

WWII half-track that came out of the site. Photo taken in 2000.



This is a dump site that contained vehicles and other items. Existence verified by interviews.

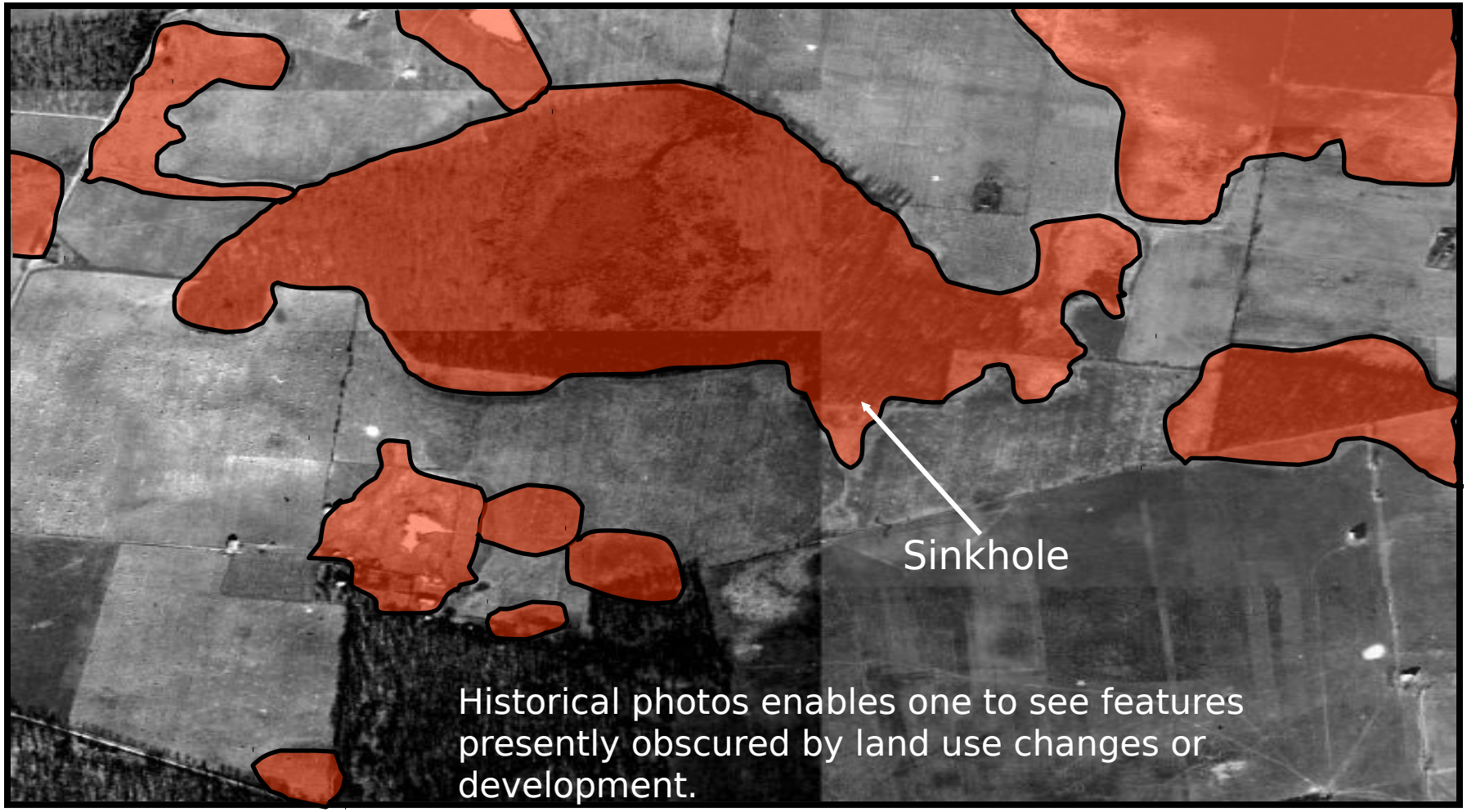
Photogeologic Analysis

Photogeologic Analysis consists of mapping surface features such as sinkholes and fractures. These features can be conduits for the migration of contaminants in the subsurface.

Current Landscape, Kentucky 1992

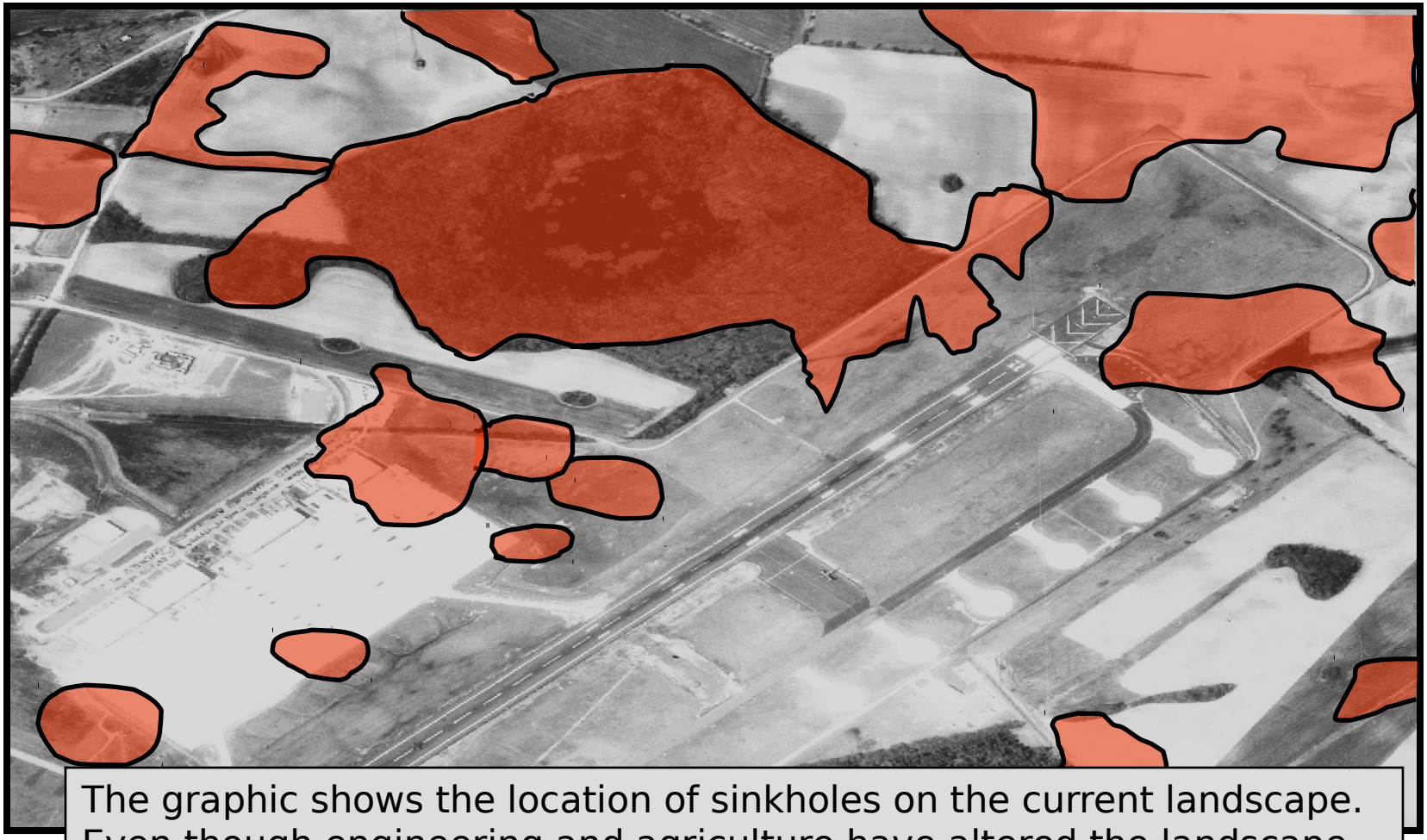
This 1992 photo shows the presence of sinkholes in an area that has changed over many years. One large sinkhole is identified.

Pre-development--1937 Historical Aerial Photograph



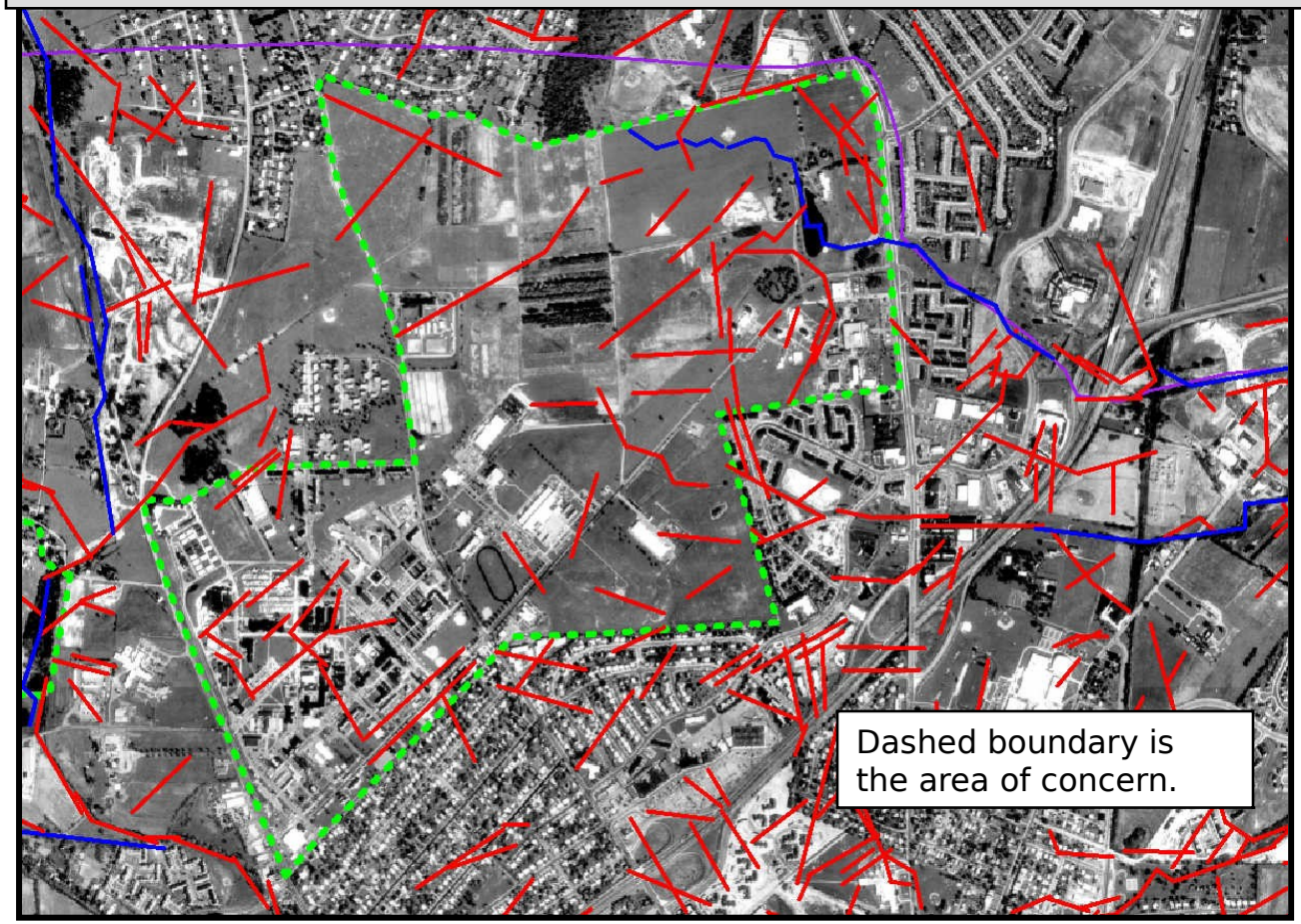
This is how the area looked 55 years earlier.

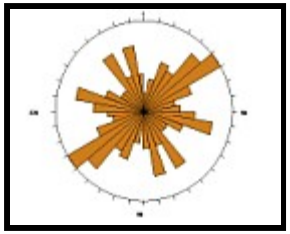
1992 Aerial Photo with 1937 Sinkhole Analysis



The graphic shows the location of sinkholes on the current landscape. Even though engineering and agriculture have altered the landscape in the area these features can still influence the migration of contaminants.

This graphic shows the location of fracture traces for an area in Maryland. The land has undergone significant changes over time. Historical photos enable us to map the potential surface fractures. This data can be helpful in establishing locations of certain geophysical surveys. Lines indicate location, length and direction of the potential fractures. Rose diagrams are generated as additional information to this historical data layer.



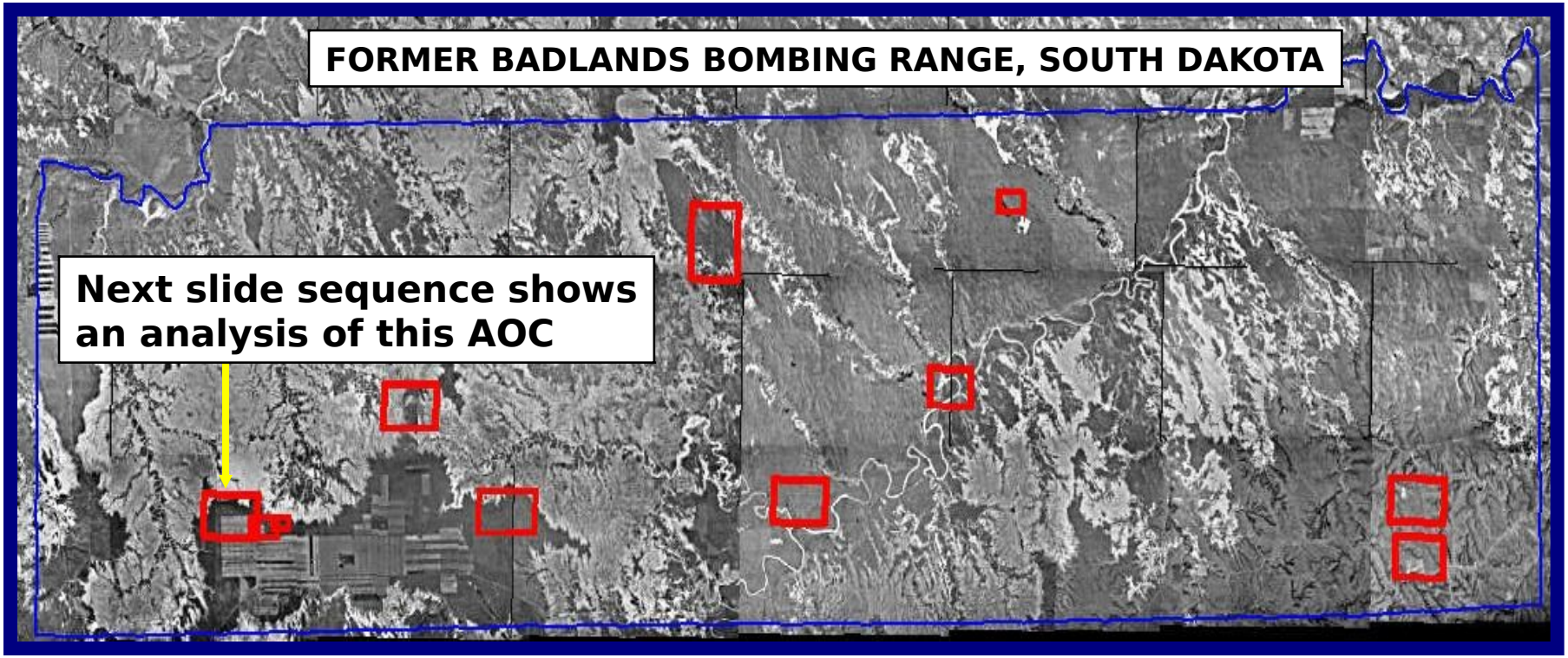


Rose Diagram indicates the number of fractures. Ray length indicates the numbers of fractures in a particular direction.

1988 Orthophoto with 1938 Fracture Traces

Another major consideration when trying to locate potential areas of contamination is the size of the area. Using aerial photos is an economical method for covering large areas.

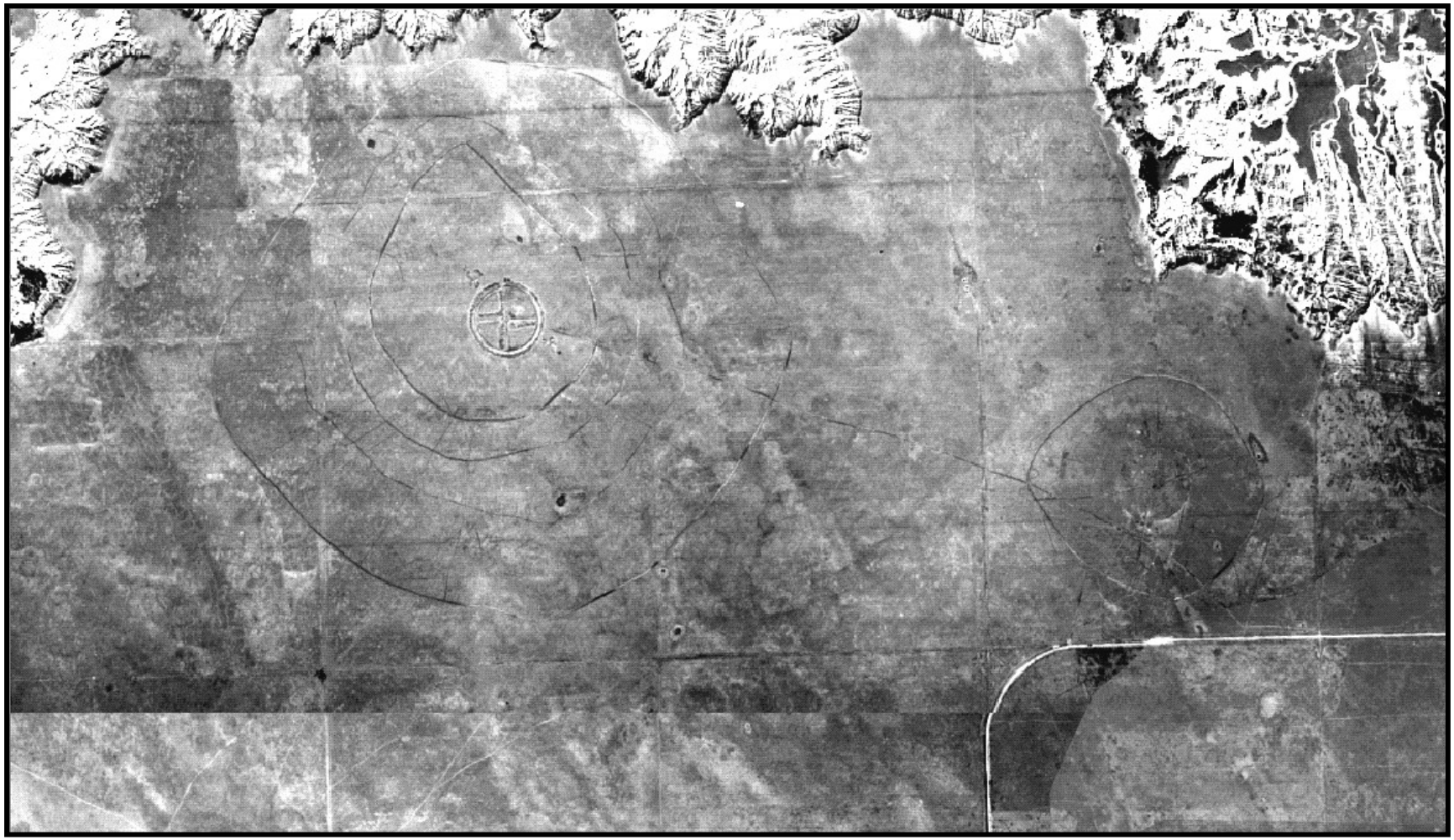
The graphic shows an example of a very large project area—about 535 square miles. Aerial photos were used to search the entire area in order to refine AOCs to those indicated below.



RED = LOCATION OF SITES (AOC)

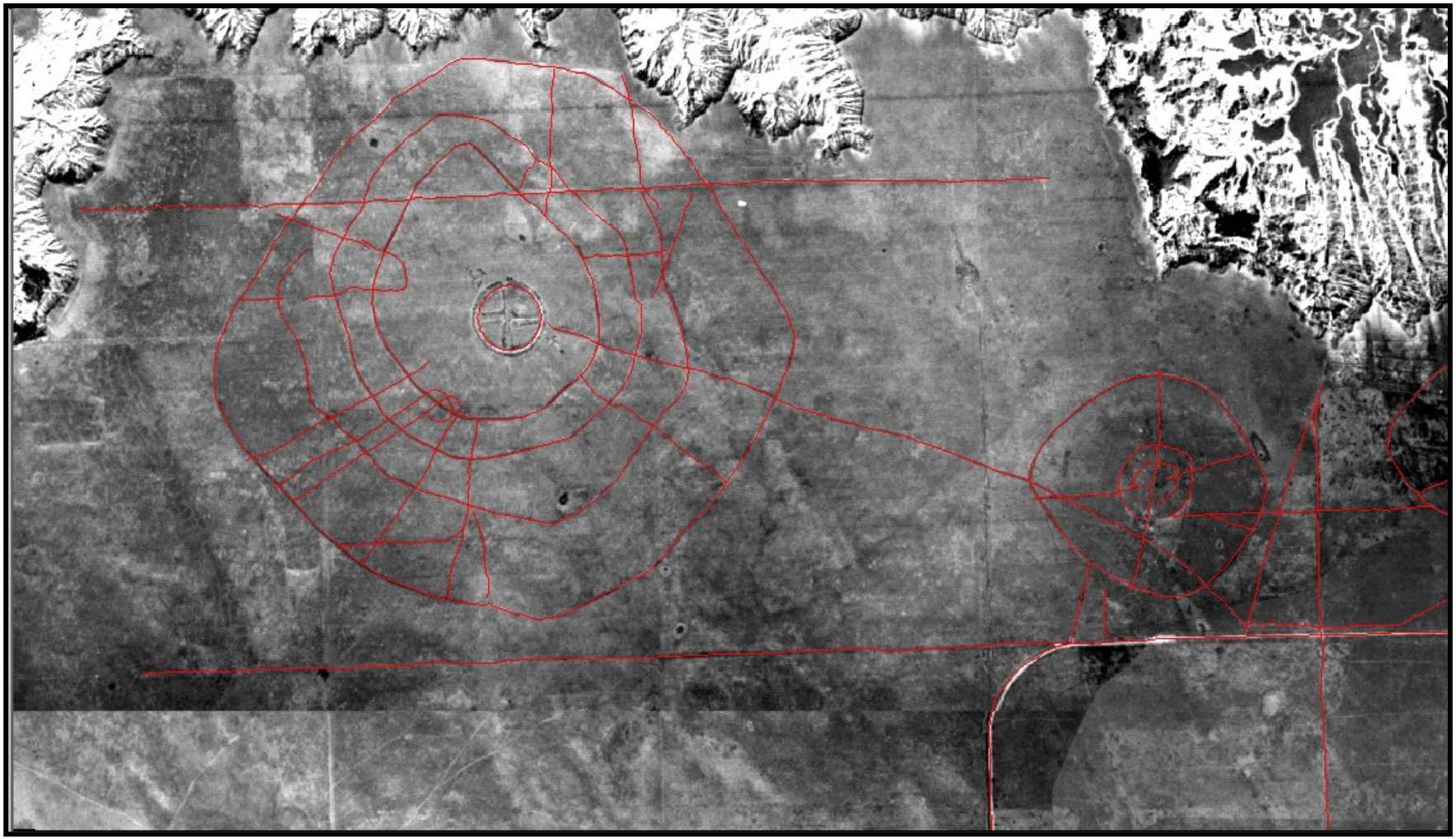
BLUE = BOUNDARY OF STUDY AREA

FORMER BADLANDS BOMBING RANGE, SOUTH DAKOTA



1954 Aerial Photograph —Target Features Seen

FORMER BADLANDS BOMBING RANGE, SOUTH DAKOTA

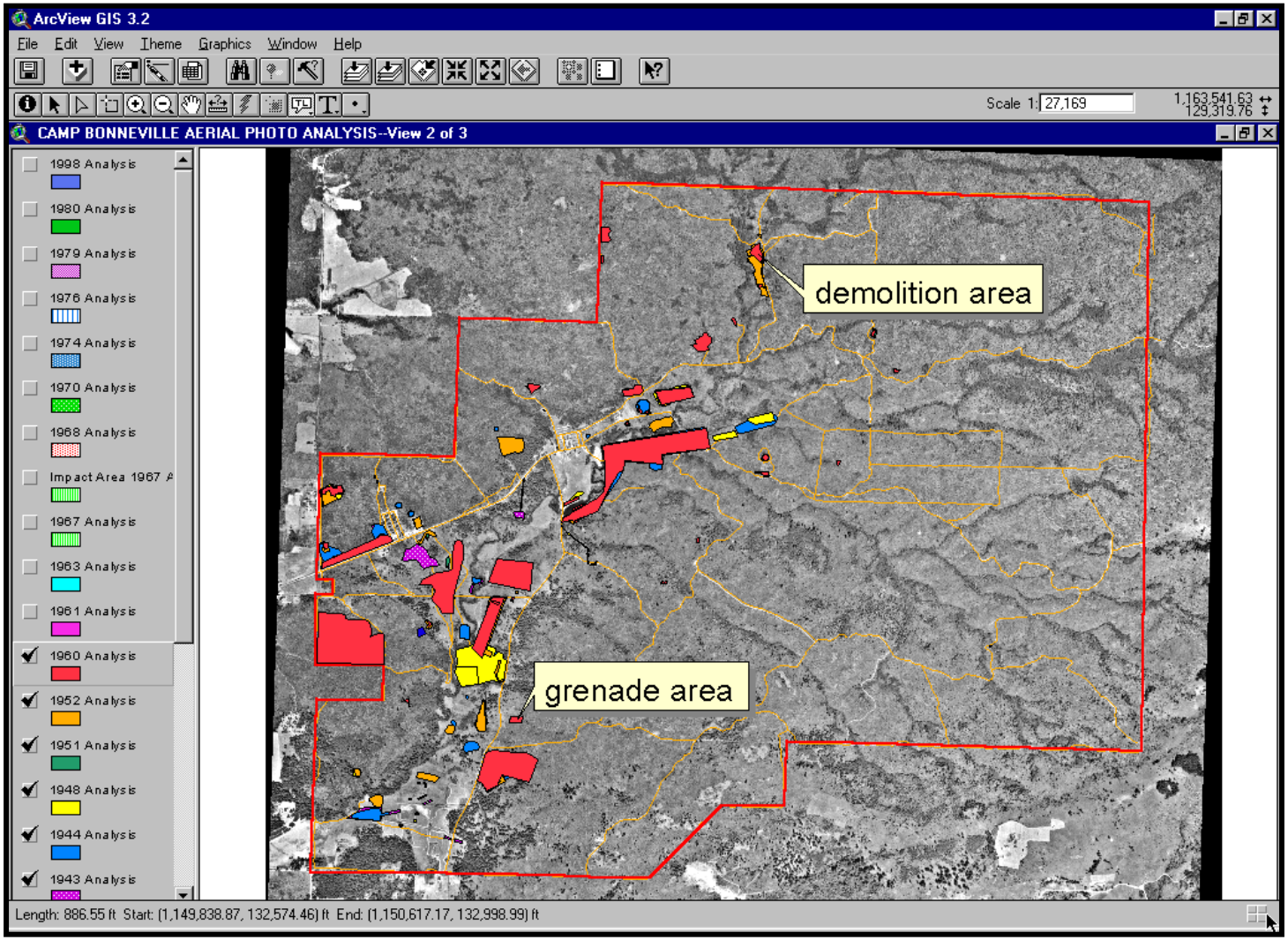


1954 Aerial Photograph —Target and Road Features Digitized

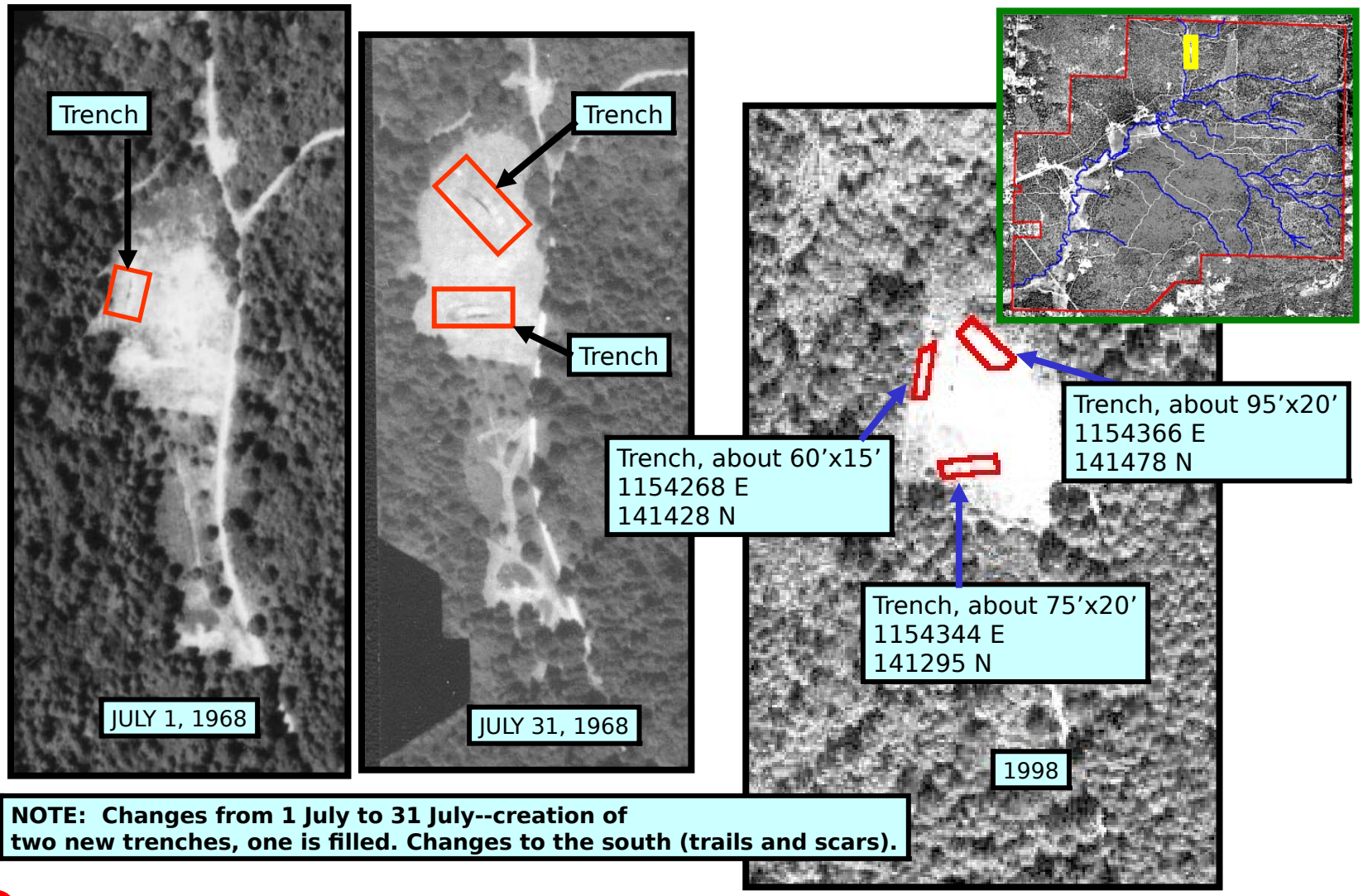
FORMER BADLANDS BOMBING RANGE, SOUTH DAKOTA

1991 Orthophoto with 1954 Features Superimposed

GIS Example (Using ArcView)
Historical Features at Camp Bonneville, Washington
Superimposed onto a 1952 Digital Orthophoto

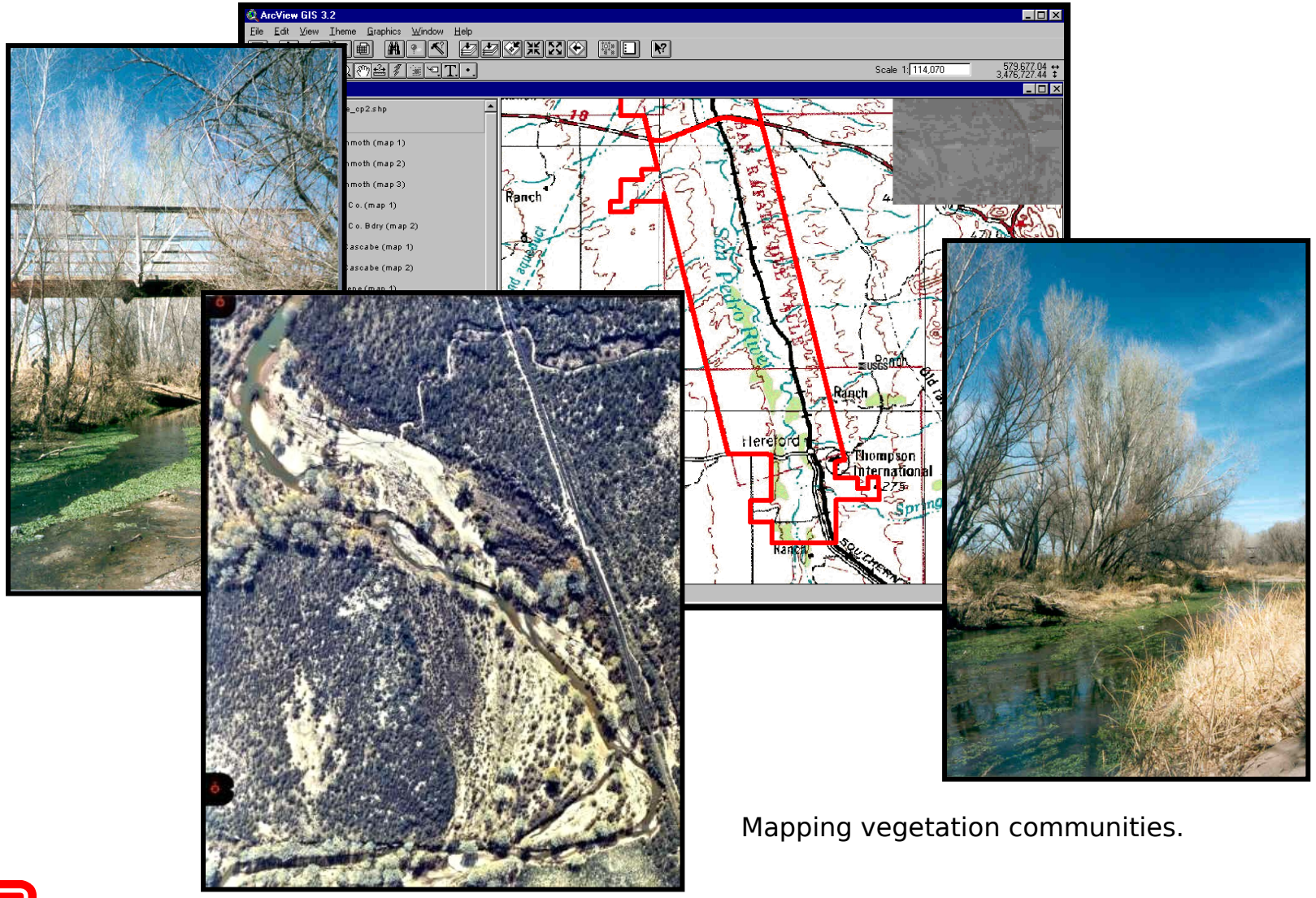


1968 features on 1968 and 1998 aerial photos at Camp Bonneville, Washington



Other environmental projects....

Riparian Analysis

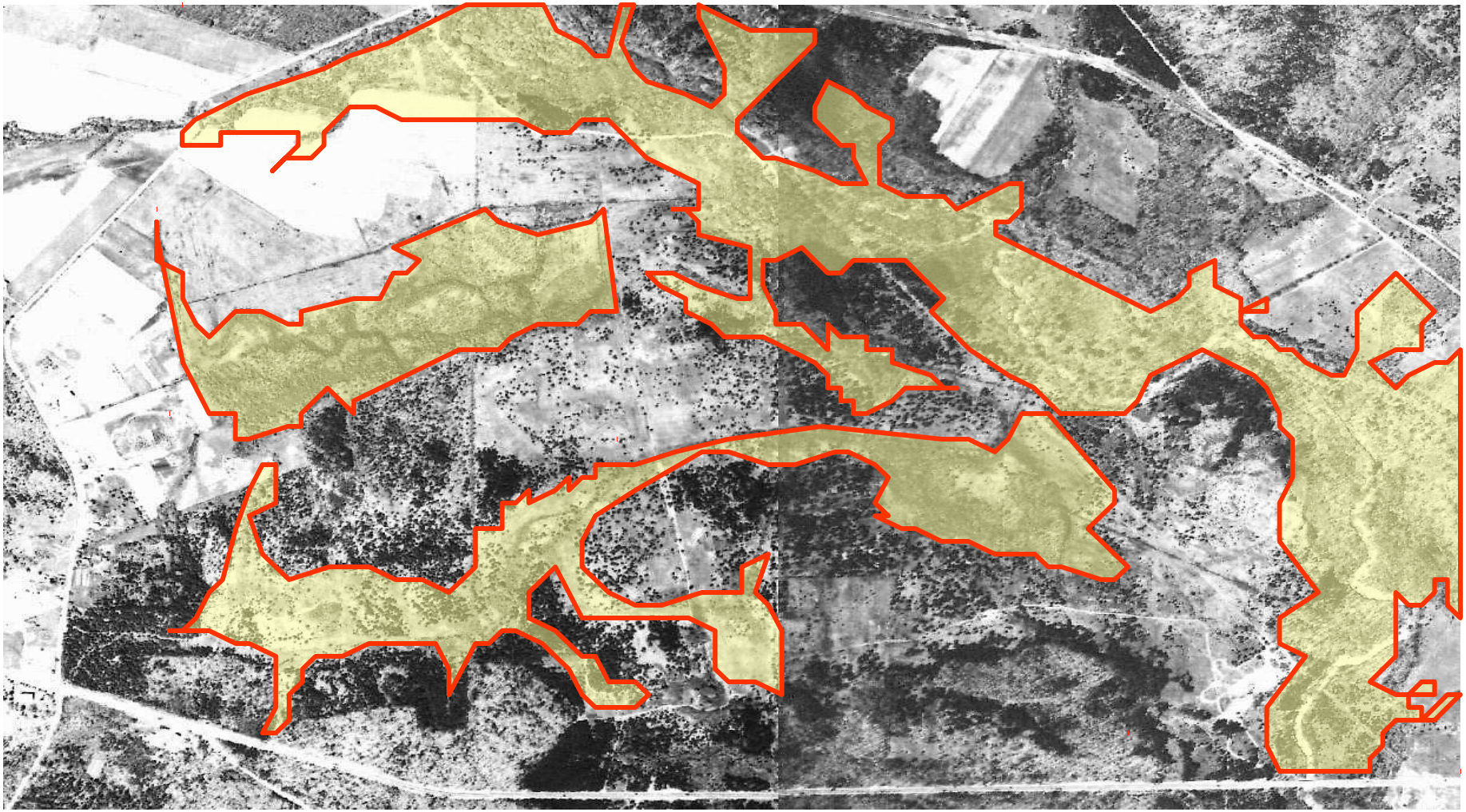


Mapping vegetation communities.

Historical Wetland Analysis

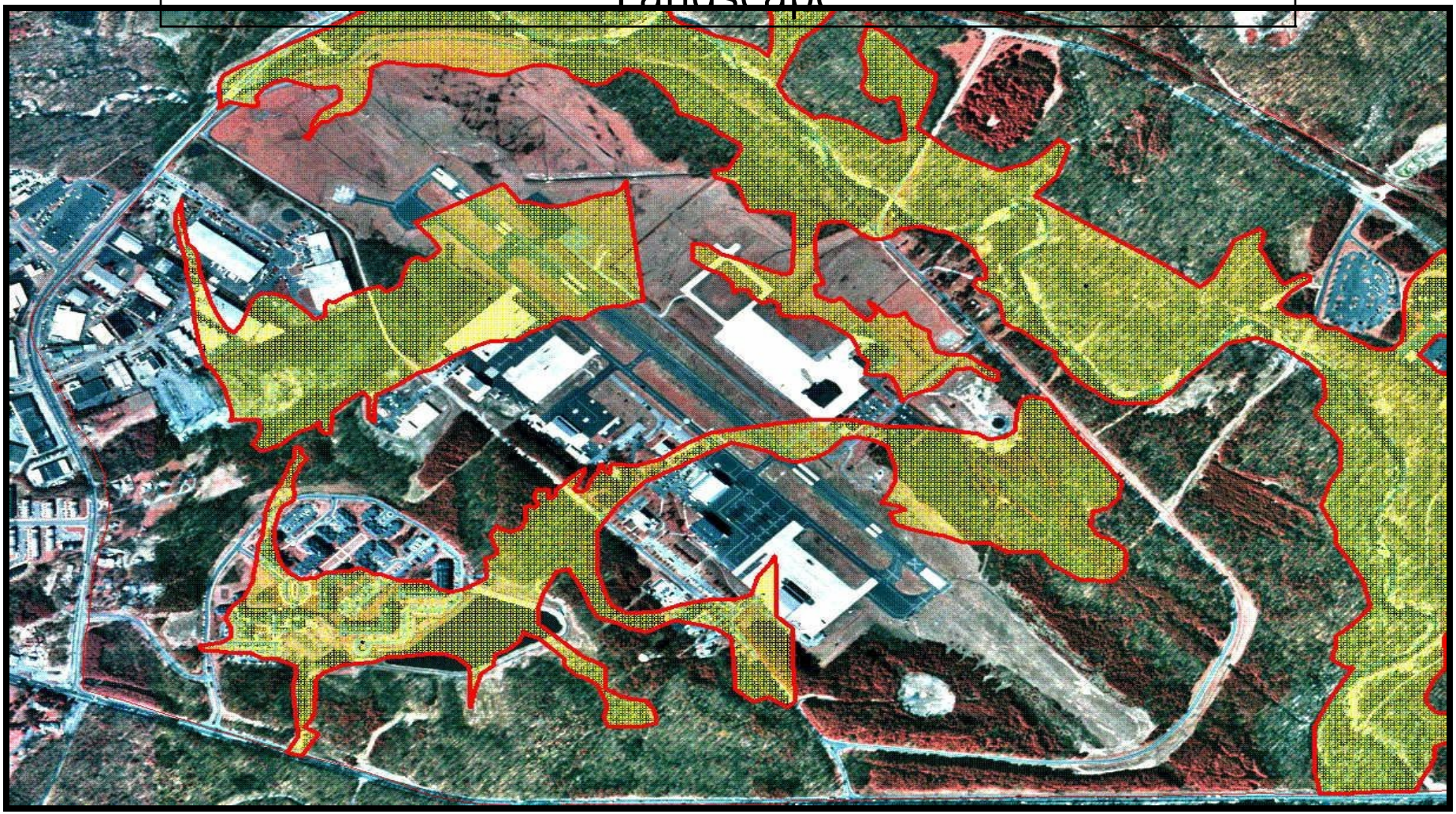
Davison Army Airfield, Virginia--Current Landscape

Historical Wetland Areas Mapped

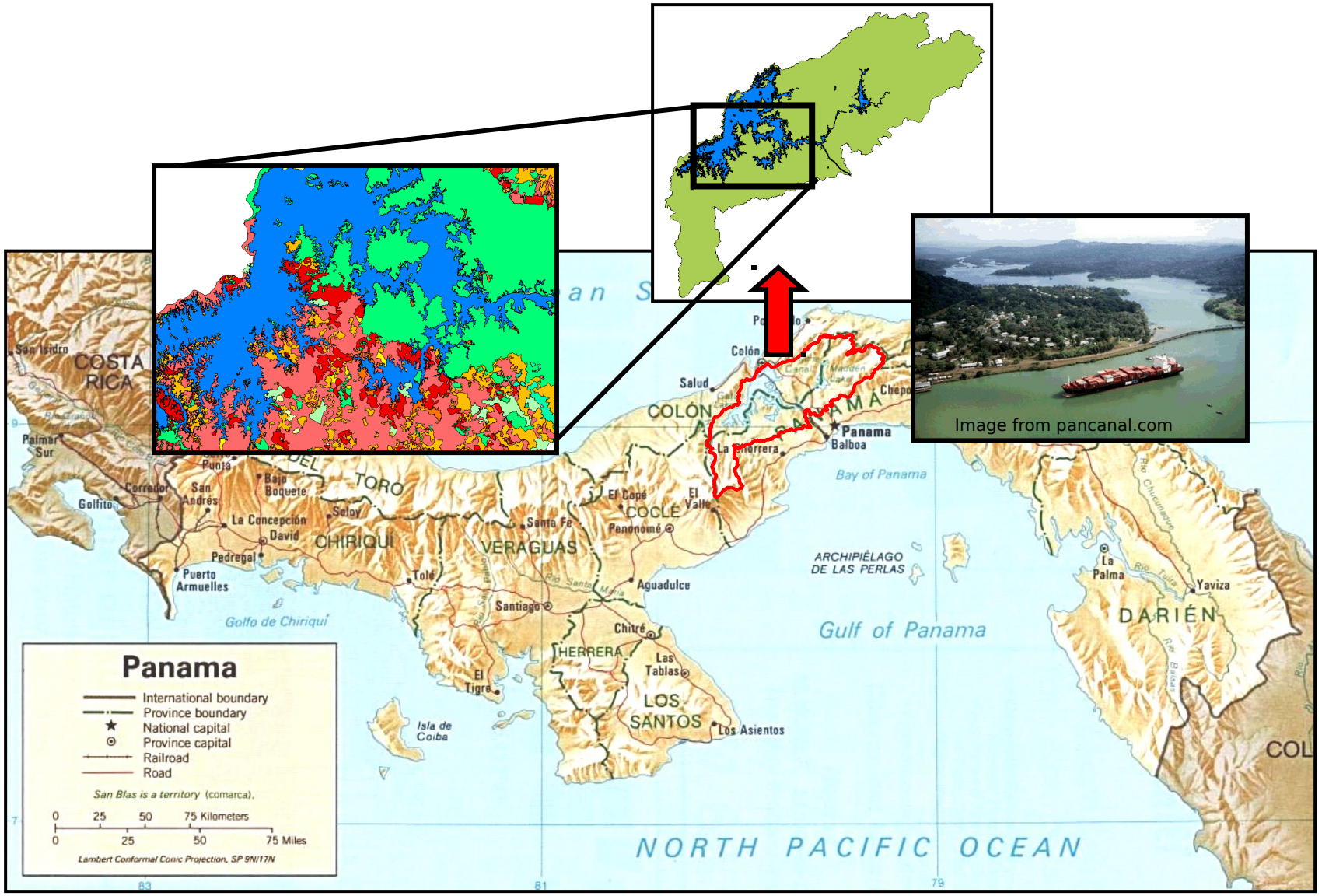


Pre-development: 1937 Historical Aerial Photo of the Area

1937 Wetlands Superimposed onto the Current Landscape

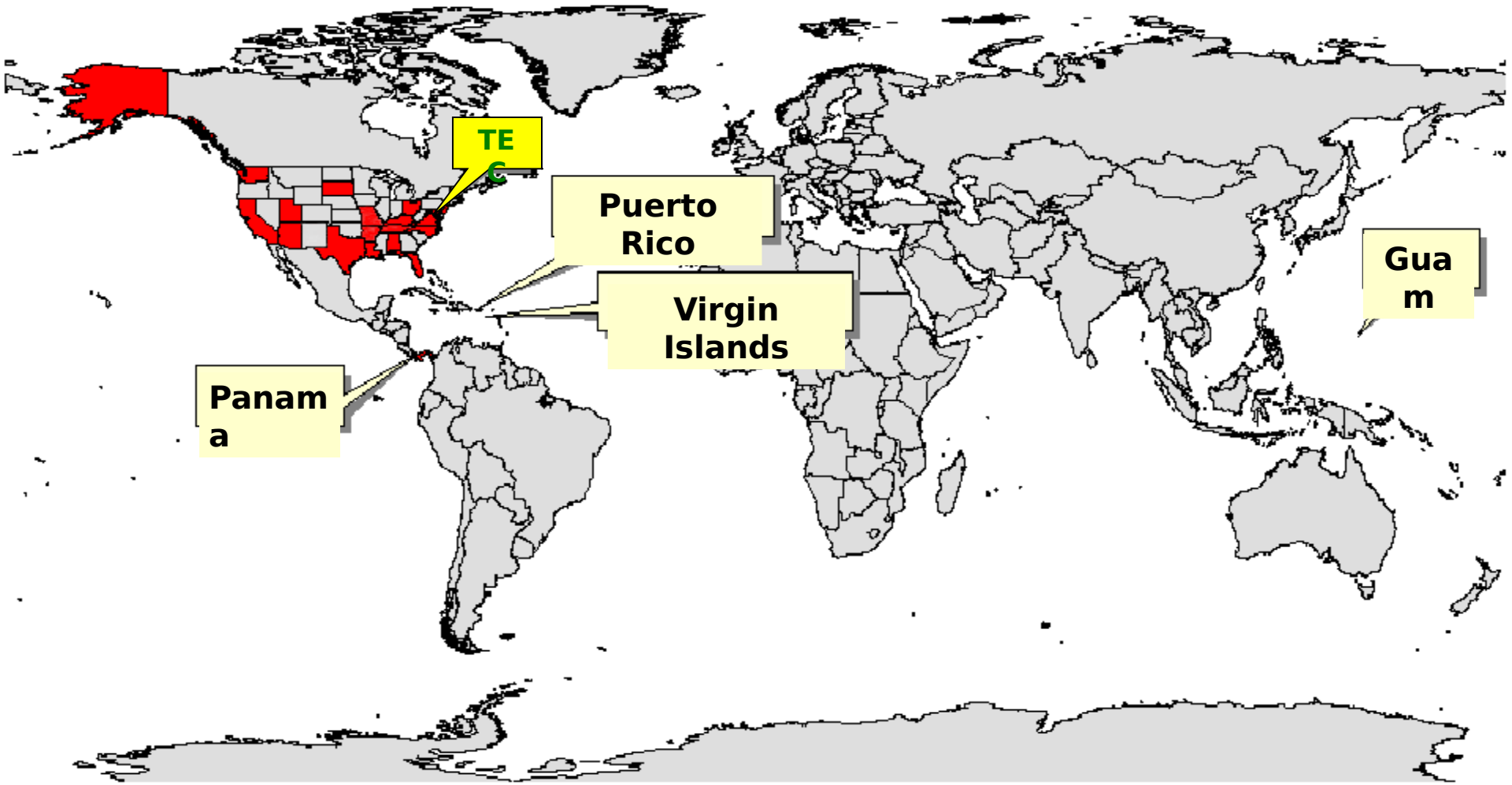


Land Use and Vegetation Cover Analysis

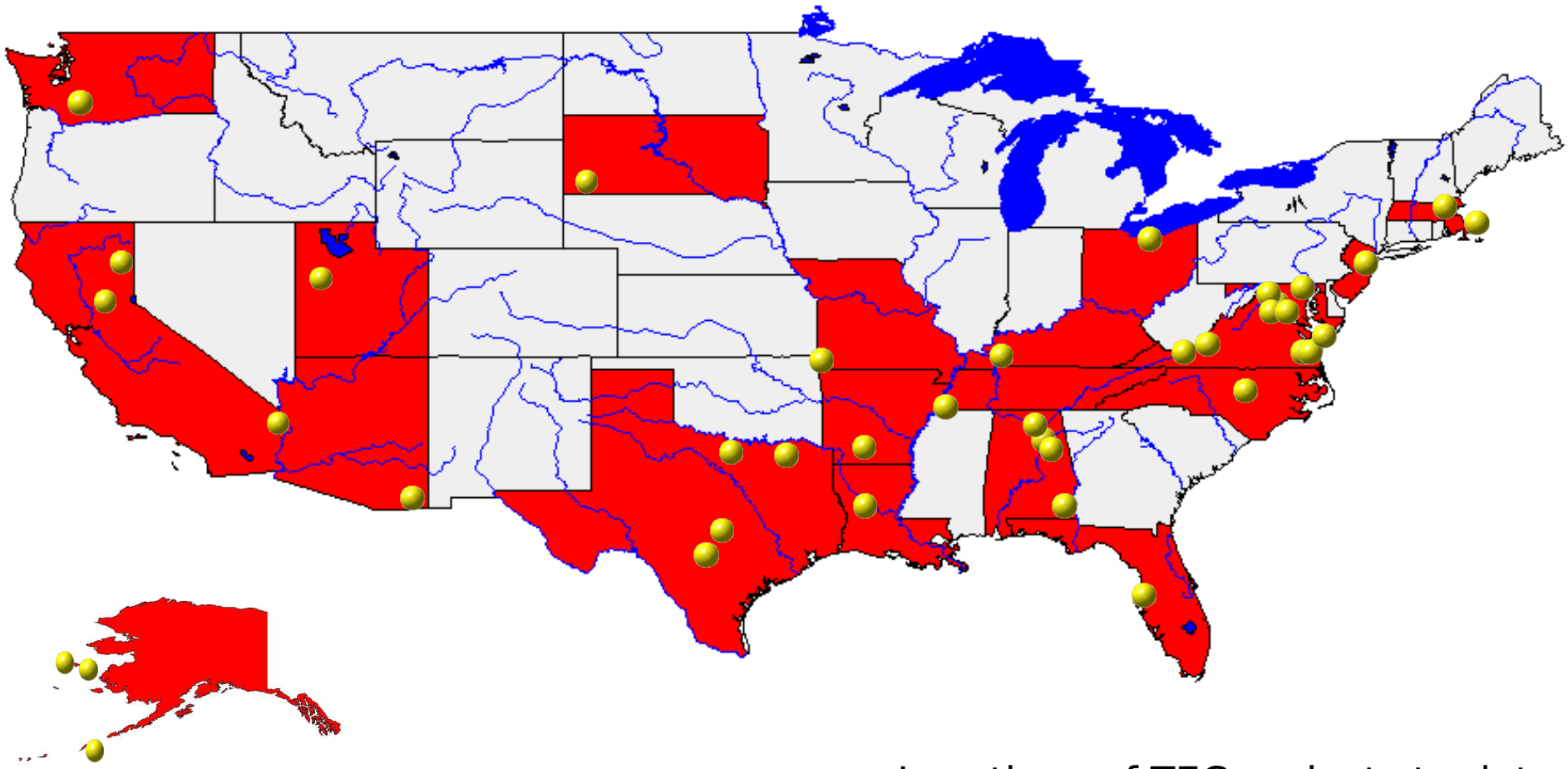


AERIAL PHOTO ENVIRONMENTAL ANALYSES: TEC Project History

1993 TO PRESENT =



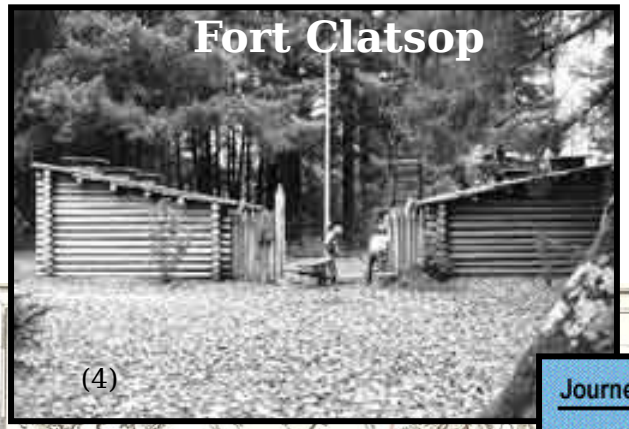
AERIAL PHOTO ENVIRONMENTAL ANALYSES: TEC Project History

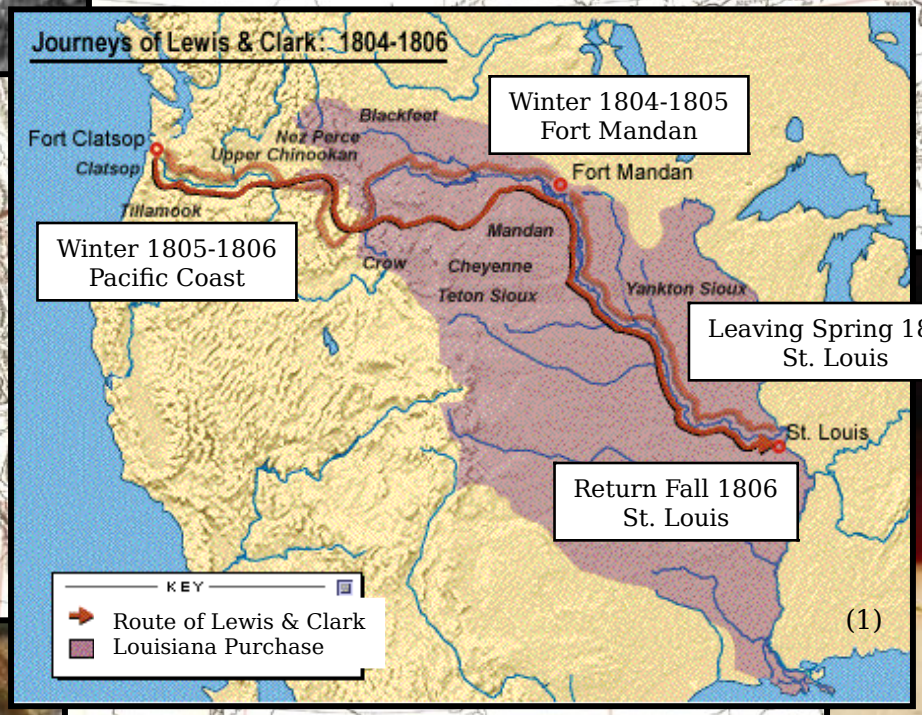


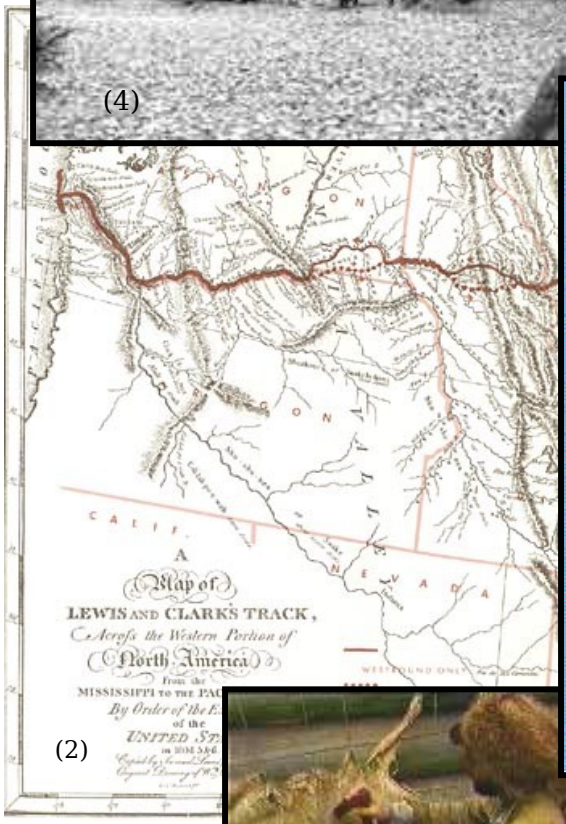
● = Locations of TEC projects to date.

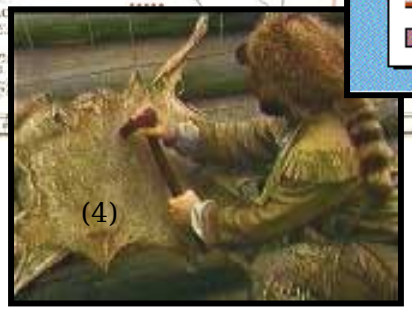
- **The use of aerial photos helps to reduce clean-up cost by refining the locations of potential areas of concern (AOC). One customer stated that it can save them as much as 10 dollars for every one dollar spent on this analysis.**
- **The historical analysis is keyed to a digital orthophoto (i.e. a photo map) in order to accurately place AOCs on the current landscape of a site. Using existing digital orthophotos is a cost savings. The historical features are mapped using GIS software which allows for a time-sequence presentation of the site.**
- **Final products are sent to customers on CDROM media, or via FTP sites. Hard copy reports and maps are also prepared for most projects.**
- **Work is customized to the users needs—not every customer needs research of documents and may just want an evaluation of one particular year of photos (for example). This enables TEC to estimate a project cost to the needs and budget constraints of the customer. Caution: If sites have an extensive history, several years of photography will probably be available, and each year can show different details. Land-use change can be significant in just a few years.**

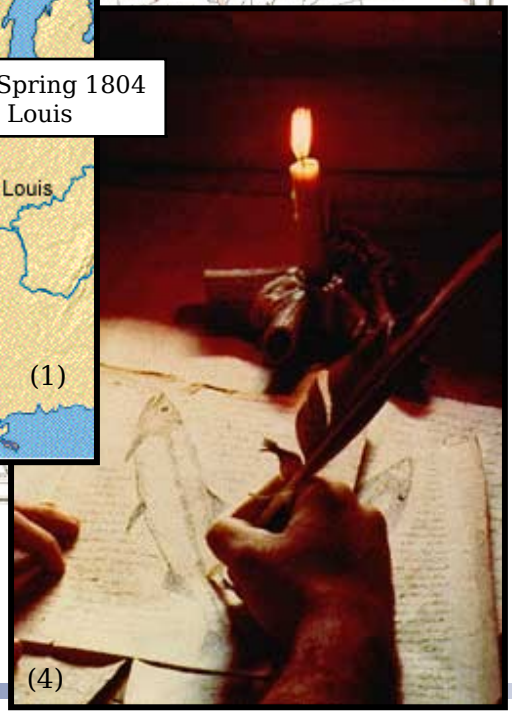
ONE LAST SLIDE TO HONOR THE THEME OF THE CONFERENCE……











Picture Sources:
1. http://www.uoregon.edu/~atlas/ (search on OSSHE)
2. http://www.lewisandclarktrail.com/clarksmap.htm
3. http://www.ucds.org/LCWeb/lcseclatsop.htm
4. http://www.nps.gov/focl/home.htm